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THE GERM-THEORY OF DISEASE.*

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SCOURGES of the human race and diseases are attributed by savages to the influence of evil spirits. Extremes often meet. What human intelligence suspected in its first dawn has been verified by human intelligence in its highest development. Again, we have come to the belief of evil spirits in disease, but these destroyers have now assumed a tangible shape. Instead of the mere passive, unwitting efforts with which we have hitherto resisted them, we now begin to fight them in their own domain with all the resources of our intellect. For they are no longer invisible creatures of our own imagination, but with that omnipotent instrument, the microscope, we can see and identify them as living beings, of dimensions on the present verge of visibility. The study of these minute foes constitutes the germ-theory.

This germ-theory of disease is rising to such importance in medical discussions that it can not be ignored by that part of the laity who aspire to a fair general information. For it has substituted a tangible reality for idle speculation and superstition so current formerly in the branch of medical science treating of the causes of disease. Formerly—that is, within a period scarcely over now—the first cause invoked to explain the origin of many diseases was the vague and much-abused bugbear "cold." When that failed, obscure chemical changes, of which no one knew anything definitely, or "impurities of the blood," a term of similar accuracy and convenience, were accused, while with regard to contagious diseases medical ignorance concealed itself by the invocation of a "genus epidemicus." The germ-theory, as far as it is applicable, does away with all these obscurities. It points out the way to investigate the causes of disease with the same spirit of in-

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quiry with which we investigate all other occurrences in nature. In the light of the germ-theory, disease is a *struggle for existence between the parts of the organism and some parasite invading it.* From this point of view, diseases become a part of the Darwinian programme of nature.

The animal body may be compared to a vast colony, consisting as it does of a mass of cells the ultimate elements of life. Each tissue, be it bone, muscle, liver, or brain, is made up of cells of its own kind, peculiar to and characteristic of the tissue. Each cell represents an element living by itself, but capable of continuing its life only by the aid it gets from other cells. By means of the blood-vessels and the nervous system, the different cells of the body are put into a state of mutual connection and dependence. The animal system resembles in this way a republic, in which each citizen depends upon others for protection, subsistence, and the supply of the requisites of daily life. Accustomed as each citizen is to this mutual interdependence, he could not exist without it. Each citizen of this animal colony, each cell, can thrive only as long as the conditions persist to which it is adapted. These conditions comprise the proper supply of food and oxygen, the necessary removal of the waste products formed by the chemical activity of all parts of the body, the protection against external mechanical forces and temperature, as well as a number of minor details. Any interference with these conditions of life impairs the normal activity of the entire body, or, as the case may be, of the individual cells concerned. But the animal system possesses the means of resisting damaging influences. Death or inactivity of one or a few citizens does not disable the state. The body is not such a rigid piece of mechanism that the breakage of one wheel can arrest the action of the whole. Within certain limits, any damage done to individual groups of cells can be repaired by the compensating powers of the organism. It is only when this compensating faculty fails, when the body can not successfully resist an unfavorable influence, that a disturbance arises which we call disease. This definition enables us to understand how external violence, improper or insufficient food, poisons, and other unaccustomed influences, can produce disease. But modern research has rendered it likely that the diseases due to such causes are not so numerous as the affections produced by invasion of the body by parasites.

Of these a few are known to be animals—for instance, the trichina, and some worms found in the blood in certain rare diseases. But the bulk of the hosts we have to contend with is of vegetable nature, and belongs to the lowest order of fungi—commonly termed *bacteria.*

Special names have been given to the different subdivisions of this class of microscopic beings—the rod-shaped bacteria being termed *bacilli;* the granular specimens, *micrococci;* while the rarer forms, of the shape of a screw, are known as *spirilla.*

Bacteria surround us from all quarters. The surface of the earth

teems with them. No terrestrial waters are free from them. They form a part of the atmospheric dust, and are deposited upon all objects exposed to the air. It is difficult to demonstrate this truth directly with the microscope, for in the dry state bacteria are not readily recognized, especially when few in number. But we can easily detect their presence by their power of multiplication. We need but provide a suitable soil. An infusion of almost any animal or vegetable substance will suffice—meat-broth, for instance—though not all bacteria will grow in the same soil. Such a fluid when freshly prepared and filtered, is clear as crystal, and remains so if well boiled and kept in a closed vessel, for boiling destroys any germs that may be present, while the access of others is prevented by closure of the flask. But as soon as we sow in this fluid a single bacterium, it multiplies to such an extent that within a day the fluid is turbid from the presence of myriads of microscopic forms. For this purpose we can throw in any terrestrial object which has not been heated previously, or we can expose the fluid to the dust of the air. Air which has lost its dust by subsidence or filtration through cotton has *not* the power of starting bacterial life in a soil devoid of germs. Of course, the most certain way of filling our flask with bacteria is to introduce into it a drop from another fluid previously teeming with them.

In a suitable soil each bacterium grows and then divides into two young bacteria, it may be within less than an hour, which progeny continue the work of their ancestor. At this rate a single germ, if not stinted for food, can produce over fifteen million of its kind within twenty-four hours ! More astounding even seems the calculation that *one* microscopic being, some forty billion of which can not weigh over one grain, might grow to the terrific mass of eight hundred tons within three days, were there but room and food for this growth !

During their growth the bacteria live upon the fluid, as all other plants do upon their soil. Characteristic, however, of bacteria-growth is the decomposition of any complex organic substances in the fluid to an extent entirely disproportionate to the weight of the bacteria themselves. This destructive action occurs wherever bacteria exist, be it in the experimental fluid, or in the solid animal or vegetable refuse where they are ordinarily found. It constitutes, in fact, rotting or putrefaction. The processes of decomposition of organic substances coming under the head of putrefaction are entirely the effect of bacterial life. Any influence, like heat, which kills the bacteria, arrests the putrefaction, and the latter does not set in again until other living bacteria gain access to the substance in question. Without bacteria, no putrefaction can occur, though bacteria can exist without putrefaction, in case there is no substance on hand which they can decompose.

No error has retarded more the progress of the germ-theory than the false belief that the bacteria of putrefaction are identical with the germs of disease. The most contradictory results were obtained in

experiments made to demonstrate on animals either the poisonous nature, or, on the other hand, the harmlessness, of the fungi commonly found in rotting refuse. But real contradictions do not exist in science; they are only apparent, because the results in any opposite cases were not obtained under identical conditions. The explanation of the variable effects of common putrefaction-germs upon animals is self-evident as soon as we admit *that each parasitic disease is due to a separate species of bacteria, characteristic of the disease*, producing only this form and no other affection; while, on the other hand, the same disease can not be caused by any other but its special parasite. It can be affirmed, on the basis of decisive experiments, that the bacteria characteristic of various diseases float in the air, in many localities at least. Hence rotting material, teeming with bacterial life, may or may not contain disease-producing germs, according to whether the latter have settled upon it by accident or not. Even if these disease-producing species were as numerous in the dust as the common bacteria of putrefaction, which we do not know, they would be at a disadvantage, as far as their increase is concerned. For experience has shown that the germs of most diseases require a special soil for their growth, and can not live, like the agents of putrefaction, upon any organic refuse. In some cases, indeed, these microscopic parasites are so fastidious in their demands that they can not grow at all outside of the animal body which they are adapted to invade. Hence, if a decomposing fluid does contain them, they form at least a minority of the inhabitants, being crowded out by the more energetically growing forms. In the microscopic world there occurs as bitter a struggle for existence as is ever witnessed between the most highly organized beings. The species best adapted to the soil crowds out all its competitors.

Though the putrefaction-bacteria, or, as Dumas calls them, the agents of corruption, are not identical with disease-producing germs, they are yet not harmless by themselves. Putrid fluids cause grave sickness when introduced into the blood of animals in *any quantity*. But this is not a bacterial disease proper; it is an instance of poisoning by certain substances produced by the life-agency of the bacteria while decomposing their soil. The latter themselves do not increase in the blood of the animal; they are killed in their struggle with the living animal cells. The putrefaction-bacteria need not be further present in the putrid solution to produce the poisonous effect on animals. They may be killed by boiling, if only the poisonous substances there formed remain.

In order to prove the bacterial origin of a disease two requirements are necessary: First, we must detect the characteristic bacteria in every case of that disease; secondly, we must reproduce a disease in other individuals by means of the isolated bacteria of that disease. Both these demonstrations may be very difficult. Some species of

bacteria are so small and so transparent that they can not be easily, if at all, seen in the midst of animal tissues. This difficulty may be lessened by the use of staining agents, which color the bacteria differently from the animal cells. But it often requires long and tedious trials to find the right dye. The obstacles in the way of the second part of the proposition mentioned are no less appalling. Having found a suspected parasite in the blood or flesh of a patient, we can not accuse the parasite with certainty of being the cause of the disease, unless we can separate it entirely from the fluids and cells of the diseased body without depriving it of its virulence. In some cases it is not easy, if possible, to cultivate the parasite outside of the body; in other instances it can be readily accomplished. Of course, all such attempts require scrupulous care to prevent contamination from other germs that might accidentally be introduced into the same soil. If we can now reproduce the original disease in other animals by infection with these isolated bacteria, the chain of evidence is complete beyond cavil and doubt. But this last step may not be the least difficult, as many diseases of mankind can not be transferred to animals, or only to some few species.

If we apply these rigid requirements, there are not many diseases of man whose bacterial origin is beyond doubt. As the most unequivocal instance, we can mention splenic fever, or anthrax, a disease of domestic animals, which sometimes attacks man, and is then known as malignant pustule. The existence of a parasite in this affection in the form of minute rods and its power of reproducing the disease are among the best-established facts in medicine. It is also known that these rods form seeds, or spores, as they are termed, in their interior, after the death of the patient, which germinate again in proper soil. These spores are the most durable and resisting objects known in animated nature. If kept in the state of spores they possess an absolute immortality; no temperature short of prolonged boiling can destroy them, while they can resist the action of most poisons, even corrosive acids, to a scarcely credible extent.

Another disease, of vastly greater importance to man, has lately been added to the list of scourges of unquestionable bacterial origin. I refer to tuberculosis, or consumption. It is true, this claim is based upon the work of but one investigator—Robert Koch. But whoever reads his original description must admit that no dart of criticism can assail his impenetrable position. Here also a rod-shaped bacillus, extremely minute and delicate, has been found the inevitable companion of the disease. With marvelous patience Koch has succeeded in getting the parasite to grow in pure blood, and freeing it from all associated matter. It must have been a rare emotion that filled the soul of that indefatigable man, when he beheld for the first time, in its isolated state, the fell destroyer of over one eighth of all mankind! None of the animals experimented upon could withstand the concen-

trated virulence of the isolated parasite. This bacillus likewise produces spores of a persistent nature, which every consumptive patient spits broadcast into the world.

Relapsing fever is another disease of definitely proved origin. If we mention, furthermore, abscesses, the dependence of which on bacteria has lately been established, we have about exhausted the list of human afflictions about the cause of which there is no longer any doubt. Some diseases peculiar to lower animals belong also to this category. The classical researches of Pasteur have assigned the silkworm disease and chicken-cholera to the same rank. Several forms of septicæmia and pyæmia have also been studied satisfactorily in animals. Indeed, the analogy between these and the kindred forms of blood-poisoning in man is so close that there can be no reasonable doubt as to the similarity of cause. This assumption, next door to certainty, applies equally to the fevers of childbirth. The experimental demonstration of the parasitic nature of leprosy, erysipelas, and diphtheria is not yet complete, though nearly so. Malarial fever also is claimed to belong to the category of known bacterial diseases, but the proofs do not seem as irreproachable to others as they do to their authors.

The entire class of contagious diseases of man can be suspected on just grounds of being of bacterial origin. All analogies, and not a few separate observations, are in favor of this view, while against it no valid argument can be adduced; but it must be admitted that the absolute proof is as yet wanting. Many diseases also, not known to be contagious, like pneumonia, rheumatism, and Bright's disease, have been found associated with parasites, the *rôle* of which is yet uncertain. It is not sophistry to look forward to an application of the germ-theory to all such diseases, if only for *the* reason that we know absolutely no other assignable cause, while the changes found in them resemble those known to be due to parasites. In the expectation of all who are not blinded by prejudice, the field is a vast one, which the germ-theory is to cover some day, though progress can only continue if we accept nothing as proved until it is proved.

There can be little doubt that in many, perhaps in most instances, the disease-producing germs enter the body with the air we breathe. At any rate, the organism presents no other gate so accessible to germs as the lungs. Moreover, it has been shown that an air artificially impregnated with living germs can infect animals through the lungs. How far drinking-water can be accused of causing sickness as the vehicle of parasites can not be stated with certainty. There is, as yet, very little evidence to the point, and what there is is ambiguous. Thus, exposed from all quarters to the attacks of these merciless invaders, it seems almost strange that we can resist their attacks to the extent that we do. In fact, one of the arguments used against the germ-theory—a weak one, it is true—is, that, while it explains why some fall victims to the germs, it does not explain why all others do not

share their fate. If all of us are threatened alike by the invisible enemies in the air we breathe, how is it that so many escape? If we expose a hundred flasks of meat-broth to the same atmosphere, they will all become tainted alike, and in the same time. But the animal body is not a dead soil in which bacteria can vegetate without disturbance. Though our blood and juices are the most perfect food the parasites require, though the animal temperature gives them the best conditions of life, they must still struggle for their existence with the cells of the animal body. We do not know yet in what way our tissues defend themselves, but that they do resist, and often successfully, is an inevitable conclusion. We can show this resistance experimentally in some cases. The ordinary putrefaction-bacteria can thrive excellently in dead blood, but if injected into the living blood-vessels they speedily perish. Disease-producing germs, however, are better adapted to the conditions they meet with in the body they invade, and hence they can the longer battle with their host, even though they succumb in the end.

The resistance or want of resistance which the body opposes to its invaders is medically referred to as the predisposition to the disease. What the real conditions of this predisposition are, we do not know. Experience has simply shown that different individuals have not an equal power to cope with the parasites. Here, as throughout all nature, the battle ends with the survival of the fittest. The invaders, if they gain a foothold at all, soon secure an advantage by reason of their terrific rate of increase. In some instances they carry on the war by producing poisonous substances, in others they rob the animal cells of food and oxygen. If the organism can withstand these assaults, can keep up its nutrition during the long siege, can ultimately destroy its assailants, it wins the battle. Fortunately for us, victory for once means victory forever, at least in many cases. Most contagious diseases attack an individual but once in his lifetime. The nature of this lucky immunity is unknown. The popular notion, that the disease has taken an alleged "poison" out of the body, has just as little substantial basis as the contrary assumption that the parasites have left in the body a substance destructive to themselves. It is not likely, indeed, that an explanation will ever be given on a purely chemical basis, but in what way the cells have been altered so as to baffle their assailants in a second attempt at invasion is as yet a matter of speculation. Unfortunately for us, there are other diseases of probable bacterial origin, which do not protect against, but directly invite, future attacks.

A question now much agitated is, whether each kind of disease-germs amounts to a distinct and separate species, or whether the parasite of one disease can be so changed as to produce other affections as well. When investigations on bacteria were first begun, it was taken for granted that all bacterial forms, yeast-cells, and mold-fungus,

were but different stages of one and the same plant. This view has long since been recognized as false. But even yet some botanists claim that all bacteria are but one species, appearing under different forms according to their surroundings, and that these forms are mutually convertible. The question is a difficult one to answer, since bacteria of widely differing powers may resemble each other in form. Hence, if a species cultivated in a flask be contaminated by other germs accidentally introduced, which is very likely to happen, the gravest errors may arise. But the more our methods gain in precision, and the more positive our experience becomes, the more do we drift toward the view that each variety of bacteria represents a species as distinct and characteristic as the separate species among the higher animals. From a medical stand-point this view, indeed, is the only acceptable one.

A disease remains the same in essence, no matter whom it attacks or what its severity be in the individual case. Each contagious disease breeds only its own kind, and no other. When we experiment with an isolated disease-producing, germ it causes always one and the same affection, if it takes hold at all.

But evidence is beginning to accumulate that, though we can not change one species into another, we can modify the power and activity, in short, the virulence, of parasites. Pasteur has shown that when the bacteria of chicken cholera are kept in an open vessel, exposed to the air for many months, their power to struggle with the animal cells is gradually enfeebled. Taken at any stage during their decline of virulence, and placed in a fresh soil in which they can grow, be it in the body of an animal or outside, they multiply as before. But the new breed has only the modified virulence of its parents, and transmits the same to its progeny. Though the form of the parasite has been unaltered, its physiological activity has been modified: it produces no longer the fatal form of chicken-cholera, but only a light attack, from which the animal recovers. By further enfeeblement of the parasite, the disease it gives to its host can be reduced in severity to almost any extent. These mild attacks, however, *protect the animal against repetitions.* By passing through the modified disease, the chicken obtains immunity from the fatal form. In the words of Pasteur, the parasite can be transformed into a "vaccine virus" by cultivation under conditions which enfeeble its power. The splendid view is thus opened to us of vaccinating, some day, against all diseases—in which one attack grants immunity against another. Pasteur has succeeded in the same way in another disease of much greater importance, namely, splenic fever. The parasite of this affection has also been modified by him, by special modes of cultivation, so as to produce a mild attack, protecting against the graver form of the disease. Pasteur's own accounts of his results, in vaccinating, against anthrax, the stock on French farms, are dazzling. But a repetition of his experiments in other countries, by his

own assistants, has been less conclusive. In Hungary the immunity obtained by vaccination was not absolute, while the protective vaccination itself destroyed some fourteen per cent of the herds.

Yet, though much of the enthusiasm generated by Pasteur's researches may proceed further than the facts warrant, he has at least opened a new path which promises to lead to results of the highest importance to mankind.

The ideal treatment of any parasitic disease would be to administer drugs which have a specific destructive influence upon the parasites, but spare their host, i. e., the cells of the animal body. But no substance of such virtue is known to us. All so-called antiseptics, i. e., chemicals arresting bacterial life, injure the body as much as if not more than the bacteria. For the latter of all living beings are characterized by their resistance to poisons. Some attempts, indeed, have been made to cure bacterial (if not all) diseases by the internal use of carbolic acid, but they display such innocent *naïveté* as not to merit serious consideration. More promising than this search after a new philosopher's stone is the hope of arresting bacterial invasion of the human body by rendering the conditions unsuitable for the development of the germs, and thus affording the organism a better chance to struggle with them. Let me illustrate this by an instance described by Pasteur. The chicken is almost proof against splenic fever. This protection Pasteur attributes to the high normal temperature of that animal, viz., 42° Cent. At that degree of warmth the anthrax-bacillus can yet develop, but it is enfeebled. The cells of the bird's body, thriving best at their own temperature, can hence overcome the enfeebled invader. Reduction of the animal's temperature, however, by means of cold baths, makes it succumb to the disease, though recovery will occur if the normal temperature be restored in due time. In the treatment of human diseases, we have not yet realized any practice of that nature, but research in that direction is steadily continuing.

The most direct outcome of the germ-theory, as far as immediate benefits are concerned, is our ability to act more intelligently in limiting the spread of contagious diseases. Knowing the nature of the poison emanated by such patients, and studying the mode of its distribution through nature, we can prevent it from reaching others, and thus spare them the personal struggle with the parasite. In no instance has the benefit derived from a knowledge of the germ-theory been more brilliantly exemplified than in the principles of antiseptic surgery inaugurated by Lister. This benefactor of mankind recognized that *the* great disturbing influence in the healing of wounds is the admission of germs. It had been well known, prior to his day, that wounds heal kindly if undisturbed, and that the fever and other dangers to life are an accidental, *not* an inevitable, consequence of wounds. But Lister was the first to point out that these accidents

were due to the entrance of germs into the wound, and that this dangerous complication could be prevented. By excluding the parasites from the wound, the surgeon spares his patient the unnecessary and risky struggle, giving the wound the chance to heal in the most perfect manner. Only he who has compared the uncertainty of the surgery prior to the antiseptic period, and the misery it was incompetent to prevent, with the ideal results of the modern surgeon, can appreciate what the world owes to Mr. Lister. The amount of suffering avoided and the number of lives annually saved by antiseptic surgery constitute the first practical gain derived from the application of the germ-theory in medicine.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

X.

AS stated in my last, the subject of roasting occupied a large amount of Count Rumford's attention, especially while he was in England residing in Brompton Road, and founding the Royal Institution. His efforts were directed not merely to cooking the meat effectively, but to doing so economically. Like all others who have contemplated thoughtfully the habits of Englishmen, he was shocked at the barbaric waste of fuel that everywhere prevailed in this country, even to a greater extent then than now.

The first fact that necessarily presented itself to his mind was the great amount of heat that is wasted, when an ordinary joint of meat is suspended in front of an ordinary coal-fire to intercept and utilize only a small fraction of its total radiation.

As far as I am aware, there is no other country in Europe where such a process is indigenous. I say "indigenous" because there certainly are hotels where this or any other English extravagance is perpetrated to please Englishmen who choose to pay for it. What is usually called roast meat in countries not inhabited by English-speaking people is what we should call "baked meat," the very name of which sets all the gastronomic bristles of an orthodox Englishman in a position of perpendicularity.

I have a theory of my own respecting the origin of this prejudice. Within the recollection of many still living, the great middle class of Englishmen lived in town; their sitting-rooms were back parlors behind their shops, or factories, or warehouses, their drawing-rooms were on the first-floor, and kitchens in the basement.

They kept one general servant of the "Marchioness" type. The corresponding class now live in suburban villas, keep cook, house-

maid, and parlor-maid, besides the gardener and his boy, and they dine at supper-time.

In the days of the one marchioness and the basement kitchen, these citizens "of credit and renown" dined at dinner-time, and were in the habit of placing a three-legged open iron triangle in a brown earthenware dish; then spreading a stratum of peeled potatoes on said dish, and a joint of meat above, on the open triangular support. The combination was carried by the marchioness to the bakehouse round the corner at about 11 A. M., and brought back steaming and savory at 1 P. M.

This was not done always, but at other times, as when the condition of the mistress's wardrobe offered no particular motive for going to church, she staid at home and roasted the Sunday dinner. The experience thus obtained demonstrated a material difference between the flavor of the roasted and the baked meat very decidedly in favor of the home-roasted. Why?

The principal reason was, I believe, that the baker's large bread-oven contained at dinner-time a curious medley of meats—mutton, beef, pork, geese, veal, etc., including stuffing with sage and onions, besides the possibility of a joint or two that had been hung longer than was necessary for procuring tenderness. The vapors of these would induce a confusion of flavors in the milder meats, fully accounting for the observed superiority of the home-roasted joints.

A little reflection on the principles already expounded will show that, theoretically regarded, a given piece of meat would be better roasted in a closed chamber radiating heat *from all sides* toward the meat than it could be when suspended in front of a fire and heated only on one side, while the other side was turned away to cool more or less, according to the rate of rotation.

If I agreed with the popular belief in the advantage of open-air exposure to direct radiation from glowing coal, I should suggest that for large joints a special roasting fire be constructed, by building an upright cylinder of fire-brick, and erecting within this a smaller cylinder or grating of iron bars, so that the fuel should be placed between these, and thus form an upright cylindrical ring or shirt of fire, inclosed outside by the bricks, but open and glowing toward the inside of the hollow cylinder, in the midst of which the meat should be suspended to receive the radiation from all sides.

The whole apparatus might stand under a dome, terminating in an ordinary chimney, like a glass-house or a steel-maker's cementing furnace; or, in this respect, like those wondrous kitchens of the old seraglio, to which I have already alluded, where each apartment is a huge chimney, outspreading downward, so that the cooks and their materials and apparatus, as well as the huge fires themselves, are all under the great central chimney-shaft.

I do not, however, recommend such an apparatus, even to the most

wealthy and luxurious epicure, because I am convinced, not merely from theoretical considerations, but also from practical experiments, that all kinds of meat may be not merely as well roasted in a close oven as before an open fire, but that the close chamber, properly managed, produces *better results in every respect* than can possibly be obtained by roasting in the open air.

To obtain such results there must be no compromise, no concession to any false theory respecting a necessity for ventilation.

Many modern kitchen-ranges are fitted with such compromises in the shape of a ventilated roasting-oven, the action of which ventilation is purely and simply mischievous, excepting in the case of semi-putrid game or venison, which require to be carbonized and disinfected as well as cooked, and, of course, also demand the speedy removal of their noxious vapors.

Not so with fresh meats. There is nothing in the vapor of beef that can injure the flavor of beef, nor in the vapor of mutton that is damaging to mutton, and so on with the rest. But there is much that can, and does, actually improve them; or, more strictly speaking, prevents the deterioration to which they are liable when roasted before an open fire. I will endeavor to explain this.

Carefully-conducted experiments have demonstrated the general law that atmospheric air is a vacuum to the vapor of water and other similar vapors, while each particular vapor is a plenum to itself, though not to other vapors; or, otherwise stated, if a given space, at a given temperature, be filled with air, the quantity of aqueous vapor that it is capable of holding is the same as though this space contained no air at all, nor anything else. But this same space may contain a much smaller quantity of aqueous vapor, and yet be absolutely impenetrable to aqueous vapor, provided its temperature is unaltered.

Thus, if a bell-glass, filled with air under ordinary pressure, at the temperature of 100° Fahr., be placed over a dish of water at same temperature, a quantity of vapor, equal to one thirtieth (in round numbers) of the weight of the air, will rise into the bell-glass, and there remain diffused throughout. If there were less air, or no air at all (temperature remaining the same), the bell-glass would obtain and hold the same quantity of vapor.

If, instead of being filled with air, it contained at the outset only this one thirtieth of aqueous vapor, it would now be an impenetrable plenum, behaving like a solid to aqueous vapor—no more can be forced into it without raising its temperature.

But while thus charged with aqueous vapor, there would still be room for vapor of alcohol, or turpentine, or ether, or chloroform, etc. It would be a vacuum to these, though a plenum to itself. On the other hand, if the alcohol, turpentine, ether, or chloroform were allowed to evaporate into the bell-glass, a certain quantity of either of these vapors would presently enter it, and then this vapor would act

like a solid mass in resisting the entry of any more of its own kind, while it would be freely pervious to the vapor of water or that of the other liquids.

A practical example will further illustrate this. Some years ago I was engaged in the distillation of paraffin-oil, and had a few thousand gallons of the crude liquid in a still with a tall head and a rising condenser. In spite of severe firing, the distillation proceeded very slowly. Then I threw into the still, just above the surface of the oil, a jet of steam. The rate of distillation immediately increased with the same firing, although the steam was of much lower temperature than the boiling oil, and therefore wasted much heat. The *rationale* of this was that at first an atmosphere of oil-vapor stood over the oil, and this was impervious to more oil-vapor, but, on sweeping this out and replacing it by steam, the atmosphere above the liquid oil was permeable by oil-vapor. This principle is largely applied in similar distillations.

But I am exceeding my limits, and must, therefore, defer the direct application of these principles to my next, though doubtless most of my readers will anticipate, or, in vulgar but expressive phrase, "see what I am driving at."

XI.

Always keeping in view that the primary problem in roasting is to raise the temperature throughout to the cooking heat with the smallest possible degree of desiccation of the natural juices of the meat, and applying to this problem the laws of vapor diffusion expounded in my last, it is easy enough to understand the theoretical advantages of roasting in a closed oven, the space within which speedily becomes saturated with those particular vapors that resist further vaporization of these juices.

I say "theoretical," because I despair of practically convincing any thorough-bred Englishman that baked meat is better than roasted meat by any reasoning whatever. If, however, he is sufficiently "un-English" to test the question experimentally, he may possibly convince himself. To do this fairly, a large joint of meat should be equally divided, one half roasted in front of the fire, the other in a non-ventilated oven over a little water by a cook who knows how to heat the latter. This condition is essential, as some intelligence is demanded in regulating the temperature of an oven, while any barbarian can carry out the modern modification of the ordinary device of the savage, who skewers a bit of meat, and holds this near enough to a fire to make it frizzle.

Having settled this question to my own satisfaction more than twenty years ago, I now amuse myself occasionally by experimenting upon others, and continually find that the most uncompromising theoretical haters of baked meat practically prefer it to orthodox roasted meat, provided always that they eat it in ignorance.

Part II of Count Rumford's "Tenth Essay" is devoted to his roaster and roasting generally, and occupies ninety-four pages, including the special preface. This preface is curious now, as it contains the following apology for delay of publication: "During several months, almost the whole of my time was taken up with the business of the Royal Institution; and those who are acquainted with the objects of that noble establishment will, no doubt, think that I judged wisely in preferring its interest to every other concern." To those who have attended the fashionable gatherings held on Friday evenings in "that noble establishment" during the London season, it is almost comical to read what its founder says concerning the object for which it was instituted, viz., the noble purpose of DIFFUSING THE KNOWLEDGE AND FACILITATING THE GENERAL INTRODUCTION OF NEW AND USEFUL INVENTIONS AND IMPROVEMENTS." The capitals are Rumford's, and he illustrates their meaning by reference to "the repository of this new establishment," where specimens of pots and kettles, ovens, roasters, fireplaces, gridirons, tea-kettles, kitchen-boilers, etc., might be inspected.

Some years ago, when I was sufficiently imprudent to accept an invitation to describe Rumford's scientific researches in *one* Friday evening lecture, rigidly limited to fifty-seven minutes (and consequently muddled my subject in the vain struggle to condense it), I tried to find the original roaster, but failed; all that remained of the original "repository" being a few models put out of the way as though they were empty wine-bottles. I am not finding fault, as the noble work that has been done there by Davy, Faraday, and Tyndall must have profoundly gladdened the supervising soul of Rumford (supposing that it does such spiritual supervision), in spite of his neglected roaster, which I must now describe without further digression.

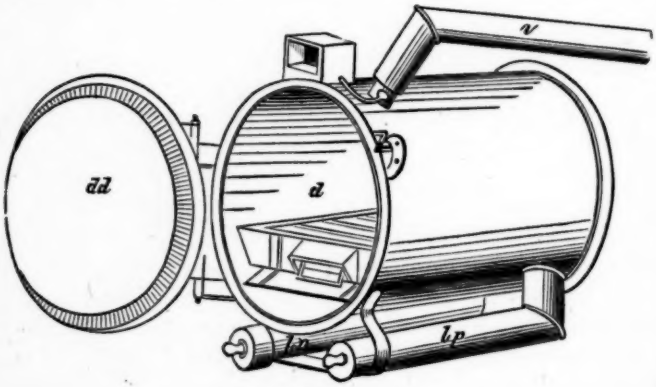

FIG. 1.

It is shown open and out of its setting in Fig. 1, and there seen as a hollow cylinder of sheet-iron, which for ordinary use may be about eighteen inches in diameter and twenty-four inches long, closed per-

manently at one end, and by a hinged double door of sheet-iron (*d d*) at the other. The doubling of the door is for the purpose of retaining the heat by means of an intervening lining of ill-conducting material. Or a single door of sheet-iron, with a panel of wood outside, may be used. The whole to be set horizontally in brickwork, as shown in Fig. 4, the door-front being flush with the front of the brickwork. The flame of the small fire below plays freely all round it by filling the enveloping flue-space indicated by the dotted lines on Fig. 4. Inside the cylinder is a shelf to support the dripping-pan (*d*), Fig. 1, which is separately shown in Figs. 2 and 3.

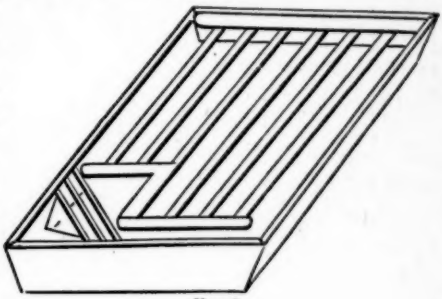

Fig. 2.

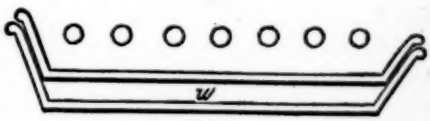

Fig. 3.

This dripping-pan is an important element of the apparatus. Fig. 3 shows it in cross-section, made up of two tin-plate dishes, one above the other, arranged to leave a space (*w*) between. This space contains water, half to three quarters of an inch in depth. Above is a gridiron, shown in plan, Fig. 2, on which the meat rests; the bars of this are shown in section in Fig. 3. The object of this arrangement is to prevent the fat which drips from the meat from being overheated and filling the roaster with the fumes of "burnt," i. e., partially decomposed, fat and gravy, to the tainting influence of which Rumford attributed the English prejudice against baked meat. So long as any water remains, the dripping can not be raised more than two or three degrees above 212°.

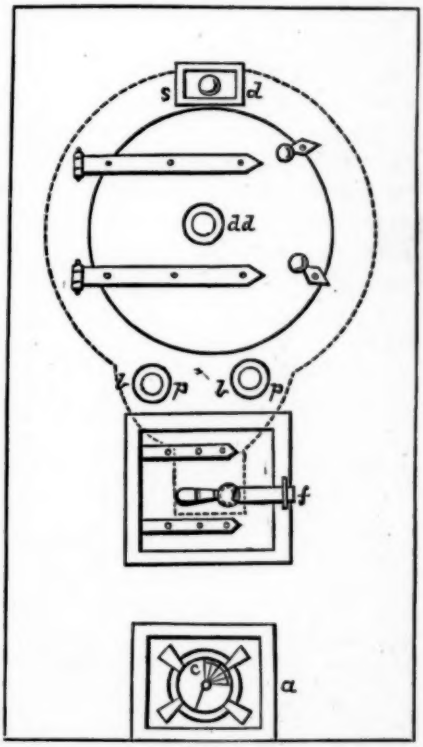

Fig. 4.

The tube *v*, Fig. 1, is for carrying away vapor, if necessary. This tube may be opened or closed by means of a damper moved by the little handle shown on the right. The *heat* of the roaster is regulated by means of the register *c* in the ash-pit door of the fireplace, its *dryness* by the above-named damper of the steam-tube *v*, and also by the blow-pipes, *b p*.

These are iron tubes, about two and a half inches in diameter, placed underneath, so as to be in the midst of the flame as it ascends from the fire into the enveloping flue, shown by the dotted lines, Fig. 4, where their external openings are shown at *b p*, *b p*, and the plugs by which they may be opened or closed in Fig. 1. It is evident that by removing these plugs and opening the damper of the steam-pipe a blast of hot, dry air will be delivered into the roaster at its back part, and it must pass forward to escape by the steam-pipe. As these blow-pipes are raised to a red heat when the fire is burning briskly, the temperature of this blast of air may be very high; with even a very moderate fire, sufficiently high to desiccate and spoil the meat if they were kept open during all the time of cooking. They are accordingly to be kept closed until the last stage of the roasting is reached; then the fire is urged by opening the ash-pit register, and when the blow-pipes are about red-hot their plugs are removed, and the steam-pipe damper is opened for a few minutes to brown the meat by means of the hot wind thus generated.

It will be observed that a special fire directly under the roaster is here designed, and that this fire is inclosed in brickwork. This is a general feature of Rumford's arrangements, which I shall have to discuss more fully when I come to the subject of kitchen-fires. The economy of the whole device will be understood by the fact that, in a test experiment at the Foundling Institution of London, he roasted one hundred and twelve pounds of beef with a consumption of only twenty-two pounds of coal (three pennyworth, at twenty-five shillings per ton).

Rumford tells us that "when these roasters were first proposed, and before their merit was established, many doubts were entertained respecting the taste of the food prepared in them," but that, after many practical trials, it was proved that "meat of every kind, without any exception, roasted in a roaster, is *better tasted, higher flavored, and much more juicy and delicate* than when roasted on a spit before an open fire." These italics are in the original, and the testimony of competent judges is quoted.

I must describe one experiment in detail. Two legs of mutton from the same carcass made equal in weight before cooking were roasted, one before the fire and the other in a roaster. When cooked both were weighed, and the joint roasted in the roaster proved to be heavier than the other by six per cent. They were brought upon table at the same time, "and a large and perfectly unprejudiced com-

pany was assembled to eat them." Both were found good, but a decided preference given to that cooked in the roaster; "it was much more juicy, and was thought better tasted." Both were fairly eaten up, nothing remaining of either that was eatable, and the fragments collected. "Of the leg of mutton which had been roasted in the roaster, hardly anything visible remained, excepting the bare bone; while a considerable heap was formed of scraps not eatable which remained of that roasted on a spit."

This was an eloquent experiment; the six per cent gained tell of juices retained with consequent gain of flavor, tenderness, and digestibility, and the subsequent testimony of the scraps describes the difference in the condition of the tendonous, integumentary portions of the joints, which are just those that present the toughest practical problems to the cook, especially in roasting.

But why are these roasters not in general use? Why did they die with their inventor? I will take up these questions in my next.

XII.

Returning to the question suggested by my last paper, Why has Rumford's roaster fallen into disuse, notwithstanding the fact, mentioned in his essay, that Mr. Hopkins, of Greek Street, Soho, had sold above two hundred, and others were making them?

Those of my readers who have had practical experience in using hot air or in superheating steam, will doubtless have already detected a weak point in the "blow-pipes." When iron pipes are heated to redness, or thereabout, and a blast of air or steam passes through them, they work admirably for a while, but presently the pipe gives way, for iron is a combustible substance, and burns slowly when heated and supplied with abundant oxygen, either by means of air or water, the latter being decomposed, its hydrogen set free, while its oxygen combines with the iron and reduces it to friable oxide. Rumford does not appear to have understood this, or he would have made his blow-pipes of fire-clay or other refractory non-oxidizable material.

The records of the Great Seal Office contain specifications of hundreds of ingenious inventions that have failed most vexatiously from this defect; and I could tell of joint-stock companies that have been "floated" to carry out inventions involving the use of heated air or superheated steam that have worked beautifully and with apparent economy while the shares were in the market, and then collapsed just when the calls were paid up, the cost of renewal of super-heaters and hot-air chambers having worse than annulled the economy of working fuel described in the prospectus. Thus a vessel driven by heated air, as a substitute for steam, was fitted up with its caloric engine, and crossed the Atlantic with passengers on board. The voyage practically demonstrated a great saving of coal; patent rights were purchased accordingly for a very large amount, and shares went up buoy-

antly until the oxidation of the great air-chamber proved that the engine burned iron as well as coal at a ruinous cost.

Although no mention is made by Rumford of such destruction of the blow-pipes, he was evidently conscious of the costliness of his original roaster, as he describes another which may be economically substituted for it. This has an air-chamber formed by bringing the body of the oven-door so as to inclose the space occupied by the blow-pipes shown in Fig. 1, and placing the dripping-pan on a false bottom joined to the front face of the roaster just below the door, but not extending quite to the back. An adjustable register door opens at the front into this air-chamber, and when this is opened the air passes along from front to back under the false bottom, and rises behind to an outlet pipe like that shown at *v*, Fig. 1. In thus passing along the hot bottom of the oven the air is heated, but not so greatly as by the blow-pipes, which, being surrounded by the flame on all sides, are heated above as well as below, and the air in passing through them is much more exposed to heat than in passing through the air-chamber.

To increase the heat transmitted in the latter, Rumford proposes that "a certain quantity of iron wire, in loose curls, or of iron turnings, be put into the air-chamber."

This modification he called a "roasting-oven," to distinguish it from the first described, the "roaster." He states that the roasting-oven is not quite so effective as the roaster, but from its greater cheapness may be largely used. This anticipation has been realized. The modern "kitchener," which in so many forms is gradually and steadily supplanting the ancient open range, is an apparatus in which roasting in the open air before a fire is superseded by roasting in a closed chamber or roasting oven. Having made three removals within the last twelve years, each preceded by a tedious amount of house-hunting, I have seen a great many kitchens of newly-built houses, and find that about ninety per cent of these have closed kitcheners, and only about ten per cent are fitted with open ranges of the old pattern. Bottle-jacks, like smoke-jacks and spits, are gradually falling into disuse.

When these kitcheners were first introduced, a great point was made by the manufacturer of the distinction between the roasting and the baking oven; the first being provided with a special apparatus for effecting ventilation by devices more or less resembling that in Rumford's roasting-oven. Gradually these degenerated into mere shams, and now in the best kitcheners even a pretense to ventilation is abandoned. Having reasoned out my own theory of the conditions demanded for perfect roasting some time ago (about 1860, when I lectured on "Household Philosophy" to a class of ladies at the Birmingham and Midland Institute), I have watched the gradual disappearance of these concessions to popular prejudice with some interest, as they show how practical experience has confirmed this theory, which, as already expounded, is that *the meat should be cooked by the*

action of radiant heat, projected toward it from all sides, while it is immersed in an atmosphere saturated with its own vapors.

Herein I diverge from my teacher, as the preceding description of both his roaster and roasting-oven shows. His explanation of the prejudice of Englishmen against baked meats may have been to some extent justified by his own experience, seeing that he heated his ovens by a fire placed below, and, if he first used these without his water-pan, they doubtless effected the decomposition of the dripping and gravy of which he speaks (see No. XI of this series, page 591); but even in this case the flavor of merely burned fat is not very serious—far less objectionable than that of the vile mixture of vapors described in No. X.

The few domestic fireplace ovens that existed in Rumford's time were clumsily heated by raking some of the fire from the grate into a space left below the oven. Those of the best modern kitcheners are heated by flues going round them, generally starting from the top, which thus attains the highest temperature. The radiation from this does the "browning" for which Rumford's blow-pipes were designed.

According to my view of the philosophy of roasting, this browning, or the application of the highest temperature, should take place at the beginning rather than the end of the process, in order that a crust of firmly coagulated albumen may surround the joint and retain the juices of the meat. All that is necessary to obtain this effect in a sufficient degree is to raise the roasting-oven to its full temperature before the meat is put in. Supposing an equal fire is maintained all the while, this initial temperature will exceed that of the continuing temperature, because, when the meat is in the oven, the radiant heat from its sides are intercepted by the joint and doing work upon it; heat can not do work without a corresponding fall of temperature. While the oven is empty, the radiations from each side cross the open space to re-enforce the temperature of the other sides.

Is there, then, any difference at all between roasting and baking? There is. In roasting, the temperature, after the first start, is maintained about uniformly throughout; while, in baking by the old-fashioned method, the temperature continually declines from the beginning to the end of the process; but, in order that a dweller in cities, or the cook of an ordinary town household, may understand this difference, some explanation is necessary. The old-fashioned oven, such as was generally used in Rumford's time, and is still used in country houses and by old-fashioned bakers, was an arched cavity of brick, with a flat brick floor. This cavity is closed by a suitable door, which, in its primitive and perhaps its best form, was a flat tile that was pressed against the opening, and luted round with clay. Such ovens were, and still are, heated by simply spreading on the brick floor a sufficient quantity of wood—preferably well-dried twigs; these, being lighted, raise the temperature of the arched roof to a

glowing heat, and that of the floor in a somewhat lower degree. When this heating is completed (the judgment of which constitutes the chief element of skill in thus baking) the embers are carefully brushed out from the floor, the loaves, etc., inserted by means of a flat battledoor with a long handle, called a "peel," and the door closed and firmly luted round, not to be opened until the operation is complete. Baked clay is an excellent radiator, and, therefore, the surface of bricks forming the arched roof of the oven radiates vigorously upon its contents below, which are thus heated at top by radiation from the roof, and at bottom by direct contact with the floor of the oven. The difference between the compact bottom crust and the darker, bubble-bearing top crust of an ordinary loaf is thus explained.

As the baking of a large joint of meat is a longer operation than the baking of bread, there is another reason besides that already given for the inferiority of meat when baked in a baker's oven constructed on this principle. The slow cooling down must tend to produce a flabbiness and insipidity similar to those of the roast meat which is served at restaurants, where a joint remains "in cut" for two or three hours. Of this I speak theoretically, not having had an opportunity of tasting a joint that has been cooked in a brick oven of the construction above described, but have observed the advantage of maintaining a steady heat throughout the process of roasting in the iron oven of a kitchener, or American stove, or gas-oven.

AGRICULTURAL EXPERIMENT STATIONS.

By H. P. ARMSBY.

WITHIN the past eight years there have been founded in several States institutions which, though they have not yet attracted much attention from the general public, can hardly fail to exert, in the near future, an important influence both on the material and mental welfare of the people. These institutions are the agricultural experiment stations, of which six now exist in this country, with a prospect of the speedy establishment of at least two more.

By an agricultural experiment station is understood an institution established and maintained "for the purpose of promoting agriculture by scientific investigation and experiments." Such institutions have, in most cases, owed their existence to governmental action, and have been sustained at the public expense, though in a few instances universities and private individuals have carried on what are in effect experiment stations, the most notable example of the latter being the well known Rothamsted experiments of Messrs. Lawes and Gilbert, in England.

Although experiment stations are still somewhat of a novelty in this country, they are far from being so in others. There is scarcely a country in Europe where one or more is not in operation, while in the German Empire they number not less than fifty. The first to be established was that at Rothamsted, just alluded to, in 1843. This has continued to the present time, though not under the name of an experiment station. Nine years later, the station at Möckern, in Saxony, which had been carried on for some two years by private and corporate generosity, received a grant of money from the state, and became the first public station. In 1853 a station was founded at Chemnitz, in 1855 one at Gross-Kmehlin, and, for the succeeding twenty-two years, 1860 was the only year which did not witness the institution of at least one station. Other European nations followed the example of the German states, and stations were established by France in 1856, by Austria in 1857, by Holland in 1857, by Sweden in 1861, by Russia in 1864, by Italy in 1870, by Denmark in 1871, by Belgium in 1872, by Switzerland in 1872, by Austro-Hungary in 1873, by Scotland in 1875, by Spain in 1876. The value of the scientific work done by these stations during the last thirty years and the impetus it has given to rational agriculture are very great. The fact that, in a volume published on the occasion of the twenty-fifth anniversary of the Möckern station, one hundred and forty-six octavo pages are occupied with a list of the *titles* of papers published by them up to that time will give some idea of its amount.

The first experiment station in this country was founded at Middletown, Connecticut, in 1875, being supported in part by the State and in part by Wesleyan University. In 1877 it was reorganized and removed to New Haven, becoming entirely dependent on State support, and in 1882 it was provided with land and buildings by the State.

In 1877 North Carolina organized a station, located first at the State University at Chapel Hill, and subsequently at Raleigh. New Jersey followed the example of these two States in 1880, placing its station at the State Agricultural College at New Brunswick. The New York station was incorporated in 1881, and began operations in 1882 at Geneva. The Ohio station was organized in April, 1882, and is located at the State University at Columbus; and the Massachusetts station was organized in the autumn of the same year, at the Agricultural College at Amherst. The private experiment stations are represented by Houghton Farm, in New York, where experimental work was begun in 1879; and mention should also be made of the Cornell University experiment station at Ithaca, which has published a single report. At least two other States are debating the question of establishing stations, and there is every indication of a rapid multiplication of them in this country in the immediate future.

With regard to the value of experimental station work in America, it is yet too early to formulate an opinion. In general it may be said

that the principal cause leading to the establishment of such stations was the great and steadily increasing extent to which commercial fertilizers are used in American agriculture, and to the absolute necessity which was felt for some means of protecting consumers against fraud in these articles, which are of such a nature that even the grossest frauds can in most cases be detected only by chemical analysis. Consequently, most of these stations were and are, first and foremost, fertilizer control stations. They put at the service of every consumer of fertilizers in their respective States the skill of professional chemists by whose aid he may test the genuineness and value of the goods he proposes to purchase. A method has also been worked out (the principle being adopted from the German stations) by which the money-value of a fertilizer may be calculated approximately from the results of analysis and the market prices of a few standard materials. Most or all of the stations follow the custom of frequently publishing analyses and valuations of the fertilizers brought to their notice, or in some cases of all brands sold in the State, and the publicity thus insured proves an efficient and sufficient check to fraudulent practices. Of late, a growing interest has manifested itself in the chemical examination of cattle-foods and their rational use, and numerous analyses of fodders have been made, accompanied in a few cases by practical feeding-trials. Other work has also been done to a less extent, but it is safe to say that, after deducting the fertilizer and fodder analyses from the work of our stations, the residue would be comparatively inconsiderable.

It was quite natural that the activity of the stations should at first take this direction. The fertilizer question was an important one, involving large money interests, and, moreover, it offered a field in which quick and tangible returns were yielded for the money invested in a station. The most short-sighted could not fail to see that the suppression of fraud in articles whose aggregate sales amounted to hundreds of thousands of dollars in single States annually was well worth the expenditure of a few thousand dollars for an experiment station. But the fertilizer question brought others in its train. Indeed, no small part of the benefit which our agriculture has derived from the introduction of commercial fertilizers has been entirely aside from the pecuniary advantage attending their use. They have aided in introducing definite ideas of what constitutes a fertilizer, and why. The habitual use of chemical analyses of fertilizers is rendering nitrogen, potash, and phosphoric acid almost as familiar terms as air, soil, and water, and thus is contributing in no small degree to the education of farmers. A knowledge of what fertilizers are has led to a demand for information as to how they act, and the most suitable method of using them, and the successes of science in this field have led to the inquiry whether the feeding of animals may not derive as much benefit from it as the feeding of plants. It would be difficult to-day to find an

intelligent farmer who is opposed to experiment stations, or who would have them limited in their operations to the analysis of fertilizers. There is a general if not always intelligent demand for scientific experiments on plant and animal production, and we may venture to predict that in future such investigations will form a more important part of the work of our experiment stations than has hitherto been the case.

It is not proposed in this article to consider the propriety of the founding of experiment stations on the part of the State. That the general welfare is sufficiently promoted thereby to justify the expense appears evident to the writer, but the question has been practically decided in so many States that any discussion of it at this late day would be quite superfluous. It seems almost certain that within a few years a great development of the business of agricultural experimentation in this country will take place. What the nature of this development shall be and how it can be guided to the best results are questions alike interesting to the agriculturist, who hopes for personal advantage from it, and the statesman, who desires the prosperity of this most important branch of industry. Nor is it material benefits alone that may be anticipated from a wise treatment of this question. The educational influence of such a center of information and research as a good station should be, the influence which it would have on the intelligence and methods of thought of its constituents, is not easily overestimated.

What, then, should an experimental station be? How should it be organized, and by whom conducted? What should the public expect from it in return for its support? By what standard judge whether it is fulfilling the purpose of its existence?

Three courses are open, any one or all of which an experiment station may pursue:

First, it may undertake police duties, and devote its energies to the prevention or detection of fraud in fertilizers, fodders, seeds, foods, etc. This species of work has of necessity occupied the larger share of the attention of the American stations thus far, and, unless other means are provided for its performance, must continue to form an important part of their duties until human nature becomes other than it is.

A second and broader field of activity, and one whose importance, we venture to think, will be more and more appreciated from year to year, provided it is wisely cultivated, consists in applying what is now known of agricultural science to the conditions prevailing where the station is located. Such work, for example, would be a physical and chemical study of the different varieties of soil in the State with regard to the kinds of fertilizers best adapted to them, the most appropriate methods of tillage, the most suitable crops, etc.—in short, an agricultural survey of the State, the benefits of which would doubt-

less, in many cases, amply repay the expense of a station. Or, the leading crops of a State might be made the subject of scientific study, either with regard to their value as food for men and animals, or as to their demands on the soil for plant-food. The number of these examples might be increased manifold were it needful. Investigations of this sort would have for their main object the adaptation of general truths to local conditions. Their benefits would be immediate and evident, and they could not fail, if intelligently conducted, to exert a salutary influence on both the agriculture and menticulture of the region.

Third, an experiment station may make it its aim to advance agricultural science in general, without regard to obtaining immediately useful results.

This would probably be the most unpopular course it could pursue. The great demand is for something "practical," by which is meant something whose value is at once apparent, and can be measured in dollars and cents. This is true in all departments of mental activity, but in none more emphatically than in the one we are considering, unless, indeed, it be in education, and nowhere does the "practical man" render his impracticality more evident. It is a difficultly learned lesson that knowledge pays. We glibly repeat the maxim that "knowledge (i. e., science) is power," but we scarcely half believe it. What we mean is that knowing how to do some particular thing or things gives us power. But knowledge *is* power, nevertheless, to every man in his own way and along his own lines of work, and no knowledge is valueless to any man. Therefore it ought to be made possible for our experiment stations, and, indeed, made part of their duty, not only to teach their constituents how to use such knowledge of agricultural science as the world now possesses, but also to aid in increasing the common stock of knowledge. They should be originators as well as distributors of science. Can any one doubt, in view of the past history of science, that such a course would be of lasting benefit to agriculture? We need not seek for striking illustrations of the practical application of the discoveries of pure science to justify such an opinion, though such illustrations lie all about us, as, for example, the electric telegraph, the coal-tar colors, and Pasteur's method of inoculation for splenic fever, to mention no more. It is not in brilliant inventions or ingenious processes that the advancement of agricultural science is chiefly to be traced, but in the gradual separation of the false from the true, in a better understanding of the reasons of old methods, and the perception of how they should be modified to meet new conditions. In short, what science does for agriculture is not so much to transform the art or its processes, though it does much in that direction, as it is to educate the artisan. It does, indeed, put many new tools into his hand, but it also teaches him how to use old and new tools to the best advantage.

Our State and national governments have recognized the importance of agricultural education by founding the agricultural colleges, and in so doing they have done well; but, unless we are prepared to maintain that we know already all that we can or all that we need of the science of agriculture, the system needs, to complete it, such provision for increasing our knowledge in this direction as well-equipped experiment stations can furnish. Despite the great advances of agricultural science in the last thirty years, there is still a vast region to be explored; there are many errors to be corrected and partial views to be extended; and, unless the professors in our agricultural colleges have and impart to their students a sense of the extent of their ignorance and a thirst for more and fuller knowledge, their instruction will be largely fruitless. We must provide for teaching the teachers. As the colleges are now situated, it is in most cases practically impossible for the professors to undertake any extended experimental work. Agricultural experimentation, especially, demands both time and money, and usually no large amount of either is available for it. It is not a work that can be taken up at odd minutes, in the intervals of other occupations, with any hope of success. It must be followed as a business, and this it can be only in an institution maintained for this purpose—i. e., in an experiment station.

It would appear, then, that agricultural experiment stations are important agents in promoting the welfare of the agricultural classes, and through them that of the whole community. They may do this by repressing fraud or adulteration, and thus preventing pecuniary loss; or, by developing practical applications of scientific principles, and thus leading to pecuniary gain; or, last, but by no means least, by promoting the advancement of agricultural science and of sound agricultural education, and so contributing both to the physical and mental well-being of important classes in the community.

We emphasize this latter function of experiment stations, not with a desire to depreciate their other uses, which are highly important, but which are also sure of general appreciation, but because it is the one most likely to be overlooked, and because it seems to us the most important of all. Our experiment stations will doubtless continue to test fertilizers, seeds, etc., as they have done, and they will, in all likelihood, extend the scope and number of their field and feeding experiments. How far they will enter upon purely scientific work it is not so easy to foretell. Many, doubtless, will take it up to a small extent, if at all, finding their time and means fully occupied with other things. It must also depend largely on the public sentiment, particularly in the case of stations supported by the State, and it is perhaps questionable whether much but "practical" work can be expected from them. Private stations, of course, would be free from any limitations arising from lack of public appreciation, and, provided their means were adequate, might very appropriately devote them-

selves to the cultivation of agricultural science. It would seem, too, that agricultural colleges or even other institutions of learning, in view of their special interest in the educational aspect of the matter, might very properly establish stations for scientific investigations bearing on agriculture, as has been done by several German universities. Here, however, financial questions would, under present circumstances, be likely to prove a serious obstacle to such a project; but, whether practicable at present or not, the question of promoting agricultural science in this way is one worthy of thoughtful attention.

A no less important question than that of the kind of work a station should do is that of who shall conduct its work, and how the station should be organized. Local circumstances will, of course, decide the form which the business organization shall take; we are concerned here only with the conduct of the actual station-work. It may be remarked in passing, however, that it is eminently desirable to keep the station out of "politics," and free from the control of "rings," and to provide it with an assured income. This much settled, to what sort of a man shall we confide the direction of the station? This must evidently depend on what the station is to be. If its business is to be simply the analysis of fertilizers, etc., what is needed is a man with sufficient technical ability for the work, and whose character will command the confidence of all parties concerned. For anything beyond this, however, something more than an analyst is needed.

An impression prevails somewhat widely that because an agricultural experiment station is designed to advance agriculture, its director must be, first of all, a practical farmer. It is said, or intimated, that only such a one can be trusted to expend the State's money in a way really profitable to agricultural interests; and the same feeling finds expression in covert sneers at scientists as "doctrinaires," and "theorists," and "impractical." We maintain, on the contrary, that the prime requisite in the director of a good experiment station is thorough scientific training. It is not necessary that he possess the highest degree of talent for original research, but a training in the scientific methods of working and thinking is absolutely indispensable to lasting success. That this is true in case the station is to be devoted mainly to scientific research will probably be admitted at once, but it is equally true when the work to be done is making so-called "practical experiments." A truly scientifically conducted practical experiment differs from those practical experiments which thinking farmers are continually trying for themselves, not in being made on a larger scale, or with a more elaborate plan, or with greater accuracy in weighing and measuring—all these differences may exist, but they are differences of degree, not of kind—but in being so conducted that at its close it is possible to know *how far the results can be trusted.*

It is this characteristic, and this alone, which gives them their greater value, and justifies the expenditure of the public funds to make them. Farmers have been experimenting since Adam was expelled from Eden, yet scarcely a meeting of farmers occurs where the most diverse opinions are not maintained on the most familiar subjects. Our experiment stations should improve on this state of things. It is a comparatively simple matter to make experiments—as simple as playing Hamlet's pipe—but to so experiment as to obtain results that will stand is quite another matter. Experimenting is an art, and requires an apprenticeship no less than music. Now, all real scientific training —cramming we do not consider—is a training in the art of experimenting, and hence the statement, that the first qualification for the director of an experiment station is scientific training, is equivalent to saying that he must have learned his trade.

In the second place, the director of an experiment station must know what experiments to make as well as how to make them. He must be familiar with the needs of agriculture on the one hand, in order not to waste time in making needless experiments ; and he must know what other experimenters have done, that he may not needlessly repeat their work.

To sum up briefly, the director of an agricultural experiment station should be a trained scientist, who has made a special study of agricultural science, and who is reasonably familiar with agricultural practice. We have named these requirements in what we believe to be the order of their importance. A certain measure of all of them is indispensable, but deficiencies in the latter two may be more or less readily made up, while lack of the first is, in our view of the matter, fatal.

Many other points regarding the organization and management of experiment stations suggest themselves for consideration, but it is the purpose of this article simply to point out the general principles which should prevail in the founding of these stations, their organization, and the determination of their lines of work. In the decision of these questions public opinion is the most powerful factor, and if this paper shall contribute in any degree to the formation of liberal and enlightened views on a subject of growing importance, or even succeed in awakening more general interest in it, and directing inquiry toward it, its object will have been accomplished.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

ASTHMA.

IT has been said that no doctrine can ever attain a large degree of popularity without containing some admixture of truth. The rare exceptions from that rule do not include that most preposterous of all medical theories, the "Brunonian System of Physics." John Brown, M. D., of Preston, Scotland, divided all disorders of the human organism into "sthenic" and "asthenic" diseases: the former produced by an excess of vitality, and to be counteracted by bleeding and cathartics; the latter arising from a defect of vital power, and to be cured by beefsteaks and brandy, etc. The grain of truth in the chaff-barrel of absolute nonsense is the pathological influence of *asthenia*, or a deficiency of vital power. Impaired vitality can not be restored by alcoholic stimulants, but its causal connection with a large number of functional disorders admits of no doubt. Every process of the animal organism derives the impulse of its normal performance from a reserve fund of vital energy and the depletion of this fund impairs the efficiency of the organic functions. A man may be too tired to sleep. A child may be too feeble to breathe, too weak to assimilate its food. Exhaustion alone may lead to that total suspension of the vital process which we call death.

But generally *asthenia* is only a proximate cause of disease. It reveals a pre-established morbid diathesis by affecting the weakest part of the organism, and its influence becomes thus localized. The affected part may become the center of attraction for a variety of asthenic agencies, for each successive attack increases the morbid diathesis, and thus, as it were, confirms the pathological precedent. This convergence of asthenic influences is most strikingly illustrated in the pathology of the asthmatic affections. Asthma, or chronic dyspnœa, a torpor of the semi-voluntary muscles which effect the process of respiration, has thus far not been traced to its original cause. Professor Reese ascribes it to a spasm of the muscular fibers inclosing the bronchial tubes; Dr. E. Bock defines it as a diminished elasticity of the pulmonary air-cells, caused by an undue dilation of the lungs (as in violent exercise). Villemin considers it as a purely nervous affection. In its most frequent form, however, it seems to be a legacy of arrested tuberculosis—an intermittent affection induced by a tendency to a pulmonary torpor that may remain latent for an indefinite time, but unmistakably connected with an asthenic proximate cause. Chronic asthma, in the strictest sense of the word, occurs only during the last stage of pulmonary consumption. When the lungs have been reduced

to a certain degree, their utmost activity is insufficient to supply the needs of the organism, and the patient suffers the tortures of an irremediable air-famine. The automatic action of the lungs has to be supplemented by a desperate muscular effort, the motions of the contracted organ become spasmodic and wheezing, the sufferer is unable to breathe in an horizontal position, and after a short slumber awakens with a sense of suffocation. But a chronic disposition to all these symptoms in their extreme malignity may exist without a phthisical diathesis, and remain latent for weeks and years. The exciting cause generally operates without a moment's warning. During the laborious digestion of a heavy dinner, or even after a moderate meal, eaten on a sultry day, the process of respiration begins to alternate with inert pauses, relieved at first by an occasional yawn, by-and-by only by a violent gasp ; a feeling of uneasiness supervenes, the air-deficit becomes more and more perceptible, and the patient suddenly realizes that he is booked for a five days' struggle with a pulmonary torpor. Changes of temperature, a sudden thaw in midwinter, or a sultry day after a protracted rain, have a similar tendency, but the most frequent proximate cause is violent mental emotion—fear, anxiety, and especially suppressed anger. Nothing else so strikingly illustrates the intimate interaction of mental and physical conditions as this sudden pathological effect of a purely physical cause. In the same instant almost, when a fit of wrath—even in the form of a transient irritation —accelerates the throbbing of the heart, its reaction on the respiratory organs betrays itself by a spasmodic gasp, the patient instinctively clutches his ribs and tries to master the incipient mischief, but emotional asthma is a form of the disease that can rarely be nipped in the bud ; the *primum mobile* can not be revoked, and the sufferer may think himself lucky to get off with a result of twenty-four hours' misery. Excessive exercise—lifting weights, running, wrestling, etc.— is merely an adjuvant of the fore-named cause. With his mind at ease, an asthmatic may chop cord-wood on the warmest day in the year, carry corn-sacks, or run up-hill till his lungs are ready to burst with panting ; that panting will be entirely distinct from the ineffectual gasps of the air-famine. But, under the depressing influence of mental worry, an exhausting physical effort will bring on a fit of asthma as surely as heat and exercise would result in perspiration.

Among the rarer proximate causes are loss of blood, starvation, nervous exhaustion from mental overwork, sexual excesses, and sudden fright, or rather the *shudder* which sometimes follows the nervous shock produced by a real or imaginary danger, as a slip of the foot at the brink of a steep declivity, a snake-panic, the unexpected visit of a stranger, etc. *Nausea* in some of its forms may produce an analogous effect. "A young lady," says a correspondent of the London "Lancet," "was sitting at dinner, apparently in perfect health. She partook, among other things, of some rabbit, and in about ten minutes or

so after she had eaten of it she was attacked with acute urticaria (nettle-rash), showing large erythematous patches and wheals very prominent on the face and neck. She then was seized with violent attacks of spasmodic asthma, which obliged her to leave the table. I inquired if she had ever suffered this before, and she informed me she had, after eating hare."*

Asthma is a warm-weather disease. The first frost mitigates its worst symptoms as surely as it would cure a fever or relieve insomnia, and "hay-asthma," often ascribed to the effect of some vegetable pollen, is probably a consequence of the relaxing influence of the first warm weather; for in midwinter, when the air is entirely free from vegetable spores, a single mild day, following upon a protracted frost, may produce symptoms exactly resembling those of a hay-catarrh. The complication of chronic bronchitis, sometimes described as bronchial asthma, should properly be called bronchial congestion, and differs from an asthmatic affection as a constipation differs from a gastric spasm. Asthma proper occurs under three forms: phthisical asthma (in the last stage of pulmonary consumption), chronic asthma, and acute spasmodic asthma. In the latter phase the disease recurs at longer intervals than in its chronic form, and limits its attacks to a few minutes or hours, but involves a greater amount of distress than any other disorder of the pulmonary organs—not excepting the pleuritic tortures of pneumonia. In pneumonia the difficulty of breathing consists in its painfulness; in asthma, in the *persistent torpor* of the respiratory organs. The patient feels as if the expansion apparatus of his chest were utterly paralyzed, the inhaled breath seems to come to the gate of the lungs and no farther; no gasping avails; the increasing distress of the air-hunger appears only to aggravate the stubbornness of the inert organ. The violence of the paroxysm often turns the color of the face into a livid purple, the throbbing of the heart becomes spasmodic, but, when the hopes of the sufferer are almost reduced to the supposed euthanasia of strangulation, the rigor suddenly relaxes, a deep gasp fills the lungs to their very bottom, and a few minutes after the breathing becomes quiet and regular, and only a cold perspiration reminds the patient that he has passed through the chill shadow of death.

As the primary cause of asthma is as yet unknown, its diathesis is not directly curable, though its latency may be prolonged by avoiding and counteracting the well-ascertained proximate causes. The mode of treatment varies with this twofold object: prevention and palliation—which frequently differ where we have to deal with spasmodic affections that call for the promptest means of relief. Thus horseback-riding is an approved cure for epilepsy, but during the progress of the fit the application of the specific might lead to strange consequences. Yacht-sailing in a storm would be a bad way of curing sea-sickness,

* Quoted in the St. Louis "Eclectic Medical Journal," June, 1883, p. 269.

though it diminishes the danger of future attacks. We have seen that a strenuous physical effort can under circumstances become the direct cause of an asthma-paroxysm, yet under proper precautions exercise is the best corrective of an asthmatic disposition; for all vital vigor is based upon muscular strength. It would be a mistake to suppose that the invigoration of the lungs alone could be a protection against asthma. An asthmatic diathesis may coexist with a perfect freedom from the usual symptoms of weak lungs; nay, chronic asthma seems to counteract the development of pulmonary phthisis. The asthmatic predisposition seems rather to consist in a general want of vital energy, and the object of the treatment should therefore be the invigoration of the whole system, not by means of "chest-expanders" alone, but by out-door life, pleasant exercise—such as gardening, hunting, or co-operative gymnastics—by a free use of cold water, and a liberal but non-stimulating diet. The latter proviso would exclude a large number of comestibles which the Brunonians would enumerate among the essentials of a "tonic regimen": The beef-and-beer cure deals in sham-remedies. We are not nourished by what we eat, but by what we digest. Plethora is not strength, but often its very opposite: the accumulation of expletive fat impairs the disease-resisting power of the organism; a gaunt wood-cutter, a wiry peddler or mail-rider, will survive epidemics that slaughter hecatombs of stall-fed burghers. The modern macrobiots, the long-lived inhabitants of the Ionian Archipelago, subsist on figs, goat-milk, and maize-bread; the herculean natives of the eastern Caucasus live on honey, barley-cakes, and poor cheese. The self-made Samson of modern times, Dr. Winship, of Boston, satisfied his craving for animal food with an occasional box of oiled sardines, and, on a diet of fruit and farinaceous dishes, spiced with daily gymnastics, made his body a complex of superhuman muscles and sinews. A constitution, built up after that pattern, might not secure the possessor against heart-disease, nor—if he confined himself to in-door gymnastics—against consumption, but it would insure him against asthma. In ninety-nine out of a hundred cases, an asthmatic disposition is combined with a deficient muscular development.

The pathological peculiarities of the disease make it safest to begin the movement-cure in midwinter, and suspend it during premature spring weather, and again during the moist, hot weeks of early summer —*June* being, *par excellence*, the asthma-month of the year. I knew people who could foretell the very week when they had to get their "asthma-weeds" ready. By a permanent suspension of his exercises an hygienic gymnast would gradually lose the gained vantage-ground, but during a few days' pause the unemployed surplus of vital energy is put at the disposition of the organism. Such pauses, therefore, become advisable whenever the premonitory symptoms of the disease indicate the agency of asthenic influences, and for greater security also after every annoying mental emotion. The occasions for such annoyances should,

however, be carefully avoided, even at the risk of incurring the penalties of social non-conformity. An asthmatic old Antwerp merchant of my acquaintance used to retire to his *gardenhuys*, a little summer-house at the farthest end of his garden, whenever his feelings became unduly excited, and also after dinner, as he had noticed that an interruption of his *siesta* was apt to react on his lungs. One afternoon, however, he had a visit from a commercial associate who had threatened to break the partnership, but now came to lubricate matters and tender a very acceptable peace-offering. At his return from the interview Mynheer made no attempt to conceal his glee, but suddenly became thoughtful and monosyllabic. "What's the matter?" asked his broker, "are you afraid it's a trap?"—"No, no," said he, "N—— is all right, but"—with a sigh—"d—n him, anyhow; it will cost me a week's tussle with old Nick." "With the asthma? What!—the mere excitement?"—"Yes," he groaned, "the talk, the miserable formalities, and the tight necktie—and right after dinner!"

Any waste of vital power may bring on a fit of spasmodic asthma, and the aggravating effect of *incontinence* is so prompt and so unmistakable that experience generally suffices to correct a *penchant* to errors in that respect. Like gout, asthma is a moral censor, but its reproofs do not so often come too late. With an ordinary amount of will-force, even persons of an inherited tendency to asthma may manage for years to keep its worst symptoms in abeyance.

Among the palliatives of spasmodic asthma COLD WATER ranks first. A plunge-bath into a pond (or tub) of water, of a sufficiently low temperature to produce a gasp and a shiver, rarely fails to break the spell of the suffocating stricture. It is the most reliable remedy, for, unlike chemical antispasmodics, it acts irrespective of precedents—its efficiency does not decrease with each subsequent application. After the second or third time, "asthma-weeds" have to be used in almost lethal doses before they produce any appreciable effect, though their disagreeable *after-effects* are perceptible enough. For these weeds are generally strong narcotic poisons. *Tabac de Chine*, or "Chinese tobacco," is a mixture of tobacco-leaves and inspissated opium. Stramonium (*Datura ferox*) is as virulent as belladonna, and the smoking of the leaves produces vertigo, heart-spasms, and violent headaches. It does relieve asthma, on the principle that diseases yield to more serious diseases. Thus the languor of dyspepsia can be temporarily relieved by alcoholic stimulants, but the dose has to be steadily increased, till the remedy becomes worse than the original evil. Such household remedies as black coffee (swallowed by the quart) or sulphur-and-vinegar fumes are liable to the same objection. They help once or twice, and afterward only in monster doses. *Coffee-poisoning*, which old *habitués* avoid by a very gradual increase of the dose, is a frequent sequel of an asthma-cure by domestic narcotics. The mediæval physicians, with their *penchant* for heroic remedies,

cured asthma with actual cautery—the application of a hot iron to the ribs of their patients, who naturally preferred the risk of suffocation: Dr. Zimmermann ascertained that the mere proposition of the hellish corrective made the delinquent gasp in a way that relieved the stricture. But the agreeable disappointment probably impaired the efficiency of subsequent threats; and the chill of a cold plunge-bath never fails to produce a contraction of the diaphragm that serves the same purpose.

After the first strangling-spell has been relieved, a very simple mechanical contrivance will help to restore the regularity of the respiration: "Take a straight stick, about six feet long and one inch in diameter, and mark it from end to end with deep notches, at regular intervals, say two inches apart, with smaller subdivisions, as on the beam of a lever-balance. Then get a ten-pound lump of pig-iron, or a large stone, and gird it with a piece of stout wire, so as to let one end of the wire project in the form of a hook. The exercise consists in grasping the stick at one end, stretching out arm and stick horizontally like a rapier at a home-thrust; then draw your arm back, and (still keeping the stick rigidly horizontal) make your hand touch your chin, thrust it out again, draw back, and so on, till the forearm moves rapidly on a steady fulcrum. Next, *load* the stick—i. e., hook the stone to one of the notches, and try to move your arm as before. It will be hard work now to keep the stick horizontal; even a strong man will find that the effort reacts powerfully on his lungs: he will puff as if the respiratory engine were working under high pressure. On the same principle, the lungs of a half-drowned man may be set awork by moving the arms up and down, like pump-handles. But the weighted stick, bearing against the sinews of the forearm, still increases this effect, and overcomes the stricture of the asthmatic spasm, as the movement of the loose arms relieves the torpor of the drowning-asphyxia" ("Physical Education," p. 137).

But a lethargic feeling about the chest still remains behind: the spasm has ceased to obstruct the entrance of the air, but breathing has still to be effected by an effort of the voluntary muscles, as if the lungs were yet too weak to perform their proper work. After an attack of spasmodic asthma this lethargy may continue for twenty-four hours; in chronic asthma, where it constitutes the chief symptom of the complaint, it may last for a week or two. Next to out-door exercise, the best corrective is *conversation*, *laughing*, and *singing*—any continued vocal effort seems to overcome the passive resistance of the torpid organ. Many physicians must have noticed that a large proportion of their asthma-patients are persons of solitary habits. Laughter is a peptic stimulant, while silence and brown studies favor dyspepsia, asthma, and sleeplessness. Bed-ridden garret-dwellers can at least talk to themselves; and, with the aid of a pet squirrel or a copy of the "Asthma-Cure Almanac," may manage to organize an occasional

private laugh. Wealthy bachelors should at once pack a valise, and (as the period of their martyrdom will generally coincide with the excursion-season) take a steamboat-ticket to some popular picnic grove, and associate with the noisiest and merriest of their traveling-companions. Mirth itself has a stimulating effect. Sorrow deadens the energy of the vital powers, for Nature is too economical to prolong a losing game, and, if the burdens of life begin to outweigh its pleasures, the organic apparatus gravitates toward a suspension of its functions. The mainspring has lost its tension. But, if life becomes visibly worth living, the soul procures a new lease of vital power; every organ seems to work with a will, and asthenia disappears without the aid of Dr. Brown's brandy-bottles. "Being happy," says Ludwig Boerne, "is a talent that can be cultivated"—certainly a talent of great hygienic value; the gift of confining the flow of ideas to a pleasant channel, of wearing roseate spectacles as others would wear an electric belt, of enjoying life by a sheer effort of will-force, may be a faculty that can only be exercised during a limited period, but that period suffices for the cure of various distressing complaints, insomnia, for instance, and many symptoms of chronic dyspepsia, but especially chronic asthma. Asthma does not prevent longevity; there are people who have smoked stramonium-leaves for half a century, and, if they had chronicled their experience, they would find that in the dullest years they had to light the greatest number of pipes. A piece of good news is worth bushels of asthma-weeds; buoyant spirits seem to react directly on the stringency of the bronchial tubes, and the relief thus obtained is not apt to be followed by a relapse.

There is also a curious correlation between asthma and *close stools*. They come and go together. Any thorough and permanent aperient serves at the same time as an asthma-cure. Drastic purges act only for a day or two, and then leave the bowels in a worse condition than before. The cathartic effect of Glauber's-salt, for instance, is almost invariably followed by an astringent reaction. For a permanent relief of costiveness a change of diet is the safest plan, and no dietetic aperient of the Graham school can compare with the three legumina—beans, lentils, and peas. Stewed prunes rank next, and next such household remedies as blackberry-soup, clabber and rye-bread, or molasses with warm water. But the aperient effect of molasses decreases after each repetition of the dose, while stewed peas taken like medicine, three times a day, will prevail where Glauber's-salt fails. As an asthma-cure it can do no harm to apply the remedy beyond the alimentary wants of the system, temporary overeating being a lesser evil than continual under-breathing. At the end of the second or third day the bowels will yield, and the simultaneous improvement of the asthma-symptoms is generally permanent.*

* Hospital statistics have revealed the fact that the inhabitants of the beer-drinking countries of Southern Germany enjoy a remarkable immunity from asthmatic affections,

In exceptionally malignant cases it may be necessary to supplement the legumen-cure by refrigeration—sponge-baths, or artificially cooled bedrooms; and while there is any danger of a relapse it is the safest plan to postpone the bed-hour beyond the usual time. After rolling and tossing about till relieved by that form of sleep which the Germans call "Ein-dämmern"—the twilight state between sleeping and waking—the patient is almost sure to start up with a feeling of strangulation, but the slumber induced by the silence and drowsiness of the small hours is not apt to be thus interrupted. Leaving the club-house at 11 P. M., or the family circle at 10; then a few hours with an interesting book, reserved for that special purpose; perhaps a little midnight lunch (but no coffee, unless habit has palliated its anti-hypnotic effect); then a somnolent old story-book; an easy-chair within reach of a boot-jack, ready to take advantage of the first drowsy spell—for those spells come and go—and a well-timed attempt will secure immediate success, with large odds in favor of a good night's rest.

An horizontal position aggravates dyspnœa, and with a few extra pillows, or by simply raising the head of the bedstead, the patient can sleep in a *half-sitting posture*, and should still further assist nature by opening the bedroom-windows, or removing his bed to the airiest place in the house. After a heavy supper, an unventilated dormitory alone can lethargize the lungs to a suffocating degree, for a nightmare is mostly nothing but a transient fit of asthma.

Fresh air, combined with a *lung-stimulating exercise*, is the last resort in an obstinate case of chronic asthma, and a foot-journey in summer adds to those stimulants the too often underrated nerve-tonic of *sunlight*. Maurus Nagy, the Hungarian *Natur-Doctor*, used to cure his asthma-patients by making them strip to the waist, and keeping them at work in his mountain-vineyard. The ancient Romans had establishments for regular sun-baths (*solaria*); and I can not help thinking that the robust health of their country population had much to do with their habit of working bareheaded and bare-shouldered in

while both among the North-German schnapps-drinkers and the abstemious natives of Southern France the complaint is almost as frequent as consumption. In explanation of the paradox some German doctors have alleged the "diffusion of the tonic effect," secured by the large quantity of the Bavarian stimulant; others, the demulcent influence of malt-liquors. The key of the enigma, I suspect, is the peptic influence of a liberal diluent. Our greasy, pungent, and concentrated diet needs a larger admixture of fluids. The dread of cold water, and of water-drinking during meals, is a consequence of the sadly-prevalent delusion that suspects the competency of our natural instincts. The food of our arboreal relatives contains at least eighty per cent of pure water; the diet of the grape-cure patients about ninety-five per cent. Instinct is a pretty safe guide in such matters, and, unless the habitual indulgence in distilled liquors has made water distasteful, the stomach craves about a pint of fluids for each pound of solid food. Fresh water is healthier than beer, but even in the form of lager-beer an abundant diluent would relieve the symptoms of gastric distress resulting from a daily struggle with an overdose of undiluted viands.

the sunlit fields, imbibing vitality at the fountain-head, for the same sun that evolved the fern-forests of the Miocene alluvium has still means of his own for quickening the vital energy of the most complex organisms. That tonic catholicon operates even through the triple teguments of a French uniform. After the tedium of a long voyage, and the delay in the Vera Cruz harbor-barracks, the French troops in Mexico suffered from a form of asthma that resisted all medication, but a six days' march through the hills of the *tierra templada* brought permanent relief, except to a few invalids who had been transported in closed ambulances. At first, though, the remedy is apt to aggravate the evil. After a couple of sleepless nights, the first day of a pedestrian tour, even through the paradise of a June landscape, is steep, up-hill work, but, with the aid of a merry traveling-companion and a light knapsack, Nature will at last prevail, and three days' hardship is a cheap price for the remission of a three weeks' daily and nightly martyrdom—besides the possible sequelæ. For the chief danger of chronic asthma is the probability of serious pathological complications. The direct result of *dyspnœa* is the impoverishment of the blood by an impeded process of aeration, and the concomitants of the disease are therefore analogous to those of pulmonary phthisis and protracted in-door life — hypertrophy of the heart, emphysema, or swelling of the lungs, inflammation of the bronchi, dropsical swellings of the extremities. Even short attacks often lead to malignant after-effects—insomnia, indigestion, headache, and a peculiar affection of the lungs that closely simulates the premonitory symptoms of pneumonia; after the asthma proper has entirely subsided, a new difficulty of breathing supervenes in the form of twitching pains in the pleura and the upper lobes of the lungs. Before the end of the second day, rest, embrocations with hot mutton-tallow, and a spare diet, generally relieve these symptoms, which follow more frequently after a drug-suppressed case of asthma than after the pedestrian-cure. The latter method of treatment is intuitively indicated by the *restlessness* of asthma-patients. The same hygienic instinct which makes a passionate longing for refrigeration a regular symptom of climatic fevers seems here to prompt peripatetic enterprises by associating in-door life with the idea of apoplexy and suffocation.

Like consumption, asthma is a house-disease. Want of fresh air and exercise will counteract all prophylactics, while the out-door liver can confine his precautions to the beginning of the warm season. A frugal diet, both as an hygienic aperient and a sedative of irate passions, will help the patient over the asthma-weeks (May and June in the north, and April and May in the lower latitudes); an airy bedroom and cold baths, over the summer season. The winter months will take care of themselves, and every year thus passed diminishes the danger of relapse.

FIRE-PROOF BUILDING CONSTRUCTION.*

By WILLIAM E. WARD.

IF society is indebted to the restless spirit of progress for most of its modern comforts and conveniences, it certainly is not yet a debtor for any methods which guarantee immunity against calamities from fire. While other departments of industry have received the benefits of improvement, the persistent use of combustible material for exposed portions of buildings has limited the intrinsic elements of the art of building construction, and confined improvements only to matters of design.

Incombustible materials are easily obtained, and, for every apparent reason, much better adapted to the purpose. Doubtless, the question of increased cost, both in money and in time required for more thorough construction, may be in a measure responsible for the tardiness in adopting safer methods; and, in addition to greater expenditure, there may have been a want of confidence in the fire-proof methods which have been offered to the public for adoption. The importance of this question induced the writer, in 1871–'72, to make some experiments in a new and special direction, for the purpose of ascertaining whether a practically fire-proof building could be designed and constructed at a comparatively moderate cost.

The incident which led the writer to the invention of iron with *béton* occurred in England in 1867, when his attention was called to the difficulties of some laborers on a quay, trying to remove cement from their tools. The adhesion of the cement to the iron was so firm that the cleavage generally appeared in the cement rather than between the cement and the iron.

The experiments which followed were confined exclusively to working up the reciprocal value of béton, in combination with iron, in the construction of beams which were designed for supporting floors and roofs made of the same material. In this particular the facts were conclusively developed that the utility of both iron and béton could be greatly increased for building purposes, through a properly adjusted combination of their special physical qualities, and very much greater efficiency be reached through their association than could possibly be realized by the exclusive use of either material, separately, in the same or in equal quantity.

Experience had long ago proved that unprotected iron, associated with combustible materials, is altogether unreliable for building purposes when exposed to a severe fire-test; but it has been demonstrated,

* Read at the meeting of the American Society of Mechanical Engineers, held in Cleveland, Ohio, June, 1883.

that, if iron is well protected by a heavy clothing of béton, its integrity can be safely depended upon in almost any emergency.

When all doubts concerning the reliability of the several combinations of materials required in the construction were removed, a building, embracing the following radical new features, was erected, for dwelling purposes, near Port Chester, New York: Not only the external and internal walls, cornices, and towers of the building were constructed of béton, but all of the beams, floors, and roofs were made exclusively of béton, re-enforced with light iron beams and rods.

Furthermore, all the closets, stairs, balconies, and porticoes, with their supporting columns, were molded from the same material; the only wood in the whole structure being window-sashes and doors, with their frames, mop-boards, and the stair-rails, thus excluding everything of a combustible nature from the main construction.

Béton can be used in any form of construction, and will serve the requirements of any architectural or decorative effects. All the exterior portions of this house, which are more or less ornamental in their functions, were made of béton in place during the progress of the work. In the interior of the house, the cornices, stiles, and panels of the ceilings are formed of béton, and covered with the hard finish usual in such work. There appears to be no limit to the reproduction in béton of any form used in stone masonry or in stucco. The proportions of material composing the béton for the work varied in strength to meet the requirements of the different parts of the structure: the heavy walls needing the least proportion of cement, while the beams, floors, and roofs required a much larger proportion. Only the best quality of Portland cement, clean beach-sand, and crushed blue-stone, were used in combination with iron for constructing the building.

The proportions used for the heavy wall-work were one part of cement to four parts of sand and fine gravel, thoroughly mixed dry, and dampened with only sufficient water to give it the consistency of well-tempered molding sand.

A finely crushed and screened, hard, blue limestone was found to be better adapted for use in combination with the béton than a coarse-sized stone filling, because small-sized stones pack closer than large ones, thereby realizing a proportional saving in cement. The tests made to ascertain the comparative transverse strength of different compositions proved that the bond was stronger in béton made with small stone. In breaking test-sections made of béton in the form of bricks, the fracture of those filled with small stone was almost invariably across the stone lying in the line of fracture, while the fracture of the test-bricks made with a filling of stone three or four times larger showed a frequent tearing away from the bond between the béton and the larger stone filling, the composition of the béton being the same in both cases.

The proportions of cement and coarse beach-sand and gravel, used in re-enforcing iron beams for floors and roof-supports, were one part of cement to two parts of sand and gravel. The size of the iron beam, selected for an experimental test, was a four-inch I-beam of lightest pattern, twelve feet long, weighing thirty pounds to the yard, and its safety load was limited to eleven hundred and fifty pounds. A plank mold was made the length of the iron beam, twelve inches deep by five inches wide, in the bottom of which a layer of béton was first moderately tamped down to an inch in thickness; then the iron beam was laid on the course at equal distances from each side of the mold, and settled down on the surface of the course of béton to a good bearing. This brought the top surface of the beam seven inches below the top of the mold. The work of filling and tamping the courses was then continued until the mold was filled.

The reason for placing the iron beam so near the bottom of the mold was to utilize its tensile quality for resisting the strain below the neutral axis when this composite beam was exposed to heavy loads, while the béton above this line was relied on for resisting compression from load-strain. The béton became thoroughly hardened in about thirty days, when the following tests of transverse strength were made: It was placed upon suitable supports, with a bearing of three inches at each end. A lever was adjusted so as to bring the testing-load on a knife-edge bearing at the center of the beam. Weight was then applied to the long end of the lever, until the stress on the center of the beam reached nine thousand five hundred pounds. Under this load there was a deflection at the center of the beam of seven sixteenths of an inch, but not a sign of rupture appeared at any point.

The load was then removed, and the beam returned to the original line it occupied before the test, showing that the combination possesses the essential quality of elasticity in addition to the enormous increase of capacity to resist strain over that which was possible for either material to sustain if used separately, and in the same quantity.

It is suggested that for future construction an inverted ⊥-beam would furnish a more preferable distribution of iron in the composite beams than the I-beams which were used.

The result of this experiment demonstrated the reliability of the composite beam of iron and béton, and showed that the adhesion of the cement to the iron could be depended on under heavy strains. This warranted the adoption of béton, re-enforced with small rods, for the floors and roofs.

The beams for supporting the floors throughout the house were placed at such convenient distances apart as to insure perfect safety to the floors, and at the same time afford ample opportunities for producing the best effects in deep, paneled ceilings.

All the beams were molded in the positions where they belonged,

both for the floors and roofs, and by the same method as the experimental beam above described. The iron beams varied in width and weight per yard in accordance with their length and the prospective load, the largest being nineteen feet long by seven inches wide. When the combination beams were completed and ready for the floors and roofs, heavy planks were firmly placed in position and securely supported between the beams, the upper surface of these plank foundations being adjusted on a level with the top surface of the molded beams. These planks served as the bottom of the floor-molds, and, after the béton forming the floor was hardened, they were removed.

Channel-ways had been molded in the walls, on a line with the top of the beams, for the purpose of supporting the outer edges of the floors.

Before the floors and roofs were laid, care was taken to cover all the supporting surfaces with paper, to prevent the adhesion of floor and roof sections to their supports. This precaution was necessary, to permit the movement of the floors and roofs that would unavoidably take place under varying temperatures and loads.

A part of the experimental system contemplated an attempt to warm the house by passing currents of heated air between the floors and ceilings, and up through flues, made in close proximity to each other, for that purpose, in the interior walls of the building; and it was necessary to core out a liberal area of lateral openings through the upper portion of the beams, in order to permit a free circulation of heated air. The ceilings rested upon flanges projecting from the lower portion of the beams, as shown in Fig. 1.

Instead of using sand and gravel, or both, in combination with cement, for floor and roof construction, the preliminary experiments that proved the superior value of broken blue-stone for massive work, led to the adoption of washed, fine screenings from the same material for the floors and roofs, because its greater angularity insured a stronger bond in the work than could be realized by using sand and gravel.

The proportions of materials used for this purpose were, one part of Portland cement to two parts of the fine stone screenings. The preparations being completed for laying down the floors, a thin course of the béton was first put on, and evenly tamped down, to about an inch in thickness, over the whole space intended to be covered. Then rods of iron, five sixteenths of an inch in diameter, were placed both longitudinally and laterally, at a uniform distance of eight inches apart, over the whole surface. Then, on this, a final layer of two inches in thickness was carefully tamped down. In about eight hours, the béton was hardened sufficiently to allow the application of the top surface, which was floated down with a half-inch coat of cement and fine beach-sand mortar, made of equal parts of each. This completed the finish, and made the whole thickness of the work three and a

half inches. It will be observed that for the same reason as in beam construction, and as before explained, the iron rods for re-enforcing were placed near the bottom of the work, so as to resist the tensional stresses due to the load, while that due to compression in the upper

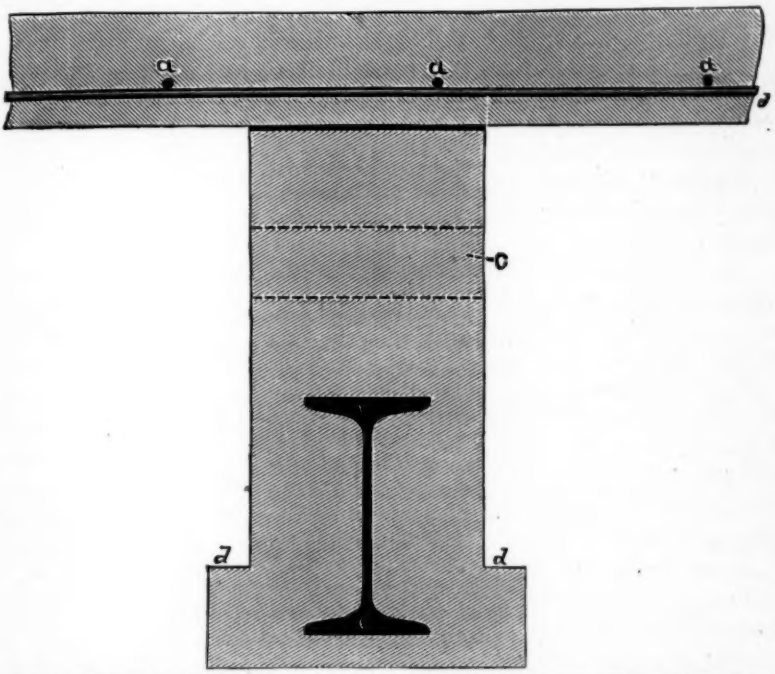

FIG. 1 REPRESENTS A RE-ENFORCED BEAM OF BÉTON SUPPORTING A SECTION OF THE FLOOR: *a a a*, ⅝-inch iron rods; *b*, same sized rods running at right angles with *a a a*; *c*, lateral openings through the beams for the circulation of heated air; *d d*, flanges supporting ceilings; *e e*, re-enforcing beam of wrought-iron.

portion would be sustained by the béton alone. In this manner, and by this process, over thirteen thousand square feet of flooring and roofing were constructed in the building.

The only test of any consequence upon the combined strength of the floors and beams together was made on a section of the widest floor in the house, where the beams are eighteen feet span and six feet between centers. Casks of plaster were placed upon the floor over the beam, forming a triangular load of thirty tons, which was sustained without any injury to the floor, or measurable permanent deflection. The dimensions of the beam that sustained this load were, seven by sixteen inches, and eighteen feet span, re-enforced in its lower portion with a seven-inch I-beam, weighing fifty-five pounds to the yard.

This test indicates that in addition to its admitted fire-resisting qualities, the re-enforced system of construction challenges comparison with other methods of building in matters of strength and of cost, whether for buildings requiring long or short floor-spans.

Experimental tests were made with several partition walls, to ascertain how thin it would be advisable to construct them where the load was small. The result of the experiments showed that the resistance of partitions eight feet in height made of béton two and a half inches thick, and re-enforced with one-quarter-inch iron rods, was equal to brick walls eight feet high, and eight inches in thickness.

It is the opinion of the writer that for the great majority of houses required for dwelling purposes, a system of thin re-enforced double walls, with a space of from six to ten inches between them, and re-enforced cross-connections every two or three feet apart, to unite the outer and inner walls firmly together, could be built up to thirty or forty feet in height, at a cost not exceeding that of first-class brick-work.

Besides an equal economy in the construction, such double walls would be an incomparably better defense against stormy weather than the best quality of brick-work, because the absorptive capacity of béton is so much less than that of brick.

Thus, all things considered, the thin double-wall system commends itself as embodying the desirable qualities, essential to the outer and inner wall construction of dwelling-houses, furnishing as it would a sure protection against both fire and dampness, and the means for thorough ventilation. Besides the special fitness of the re-enforcing system for floors, roofs, beams, and thin walls, it is an interesting question whether the same system may not be also applicable, and advantageously extended, to a more general use in many engineering requirements—especially in situations where immense weights must be sustained, and where iron construction alone is difficult of application; notably in such an important work as the Hudson River Tunnel, where its tubular form is constructed with an outer cylindrical shell of flue-iron, and lined inside with heavy brick mason-work. Much of this tunnel rests upon a treacherous bed of silt, and might be made absolutely safe from rupture by settling, induced by vibrations resulting from railroad traffic in addition to its own weight, by adding to a thin brick lining a strong béton sixteen or eighteen inches thick, which should include three or four courses of iron bars, of suitable size, laid longitudinally and in sufficient number to bear any amount of strain that might be brought upon it. Rings of flat bar-iron, interspersed in the béton-lining a few feet apart, would further add to its security.

The re-enforced béton system has also been employed with admirable results, in heavy foundations, for stationary engines. The writer, three years ago, mounted a two-hundred-and-fifty-horse-power, tandem, compound engine, of very heavy pattern, on a re-enforced béton-bed, twenty-three feet long, five feet wide, and seven feet deep. It is apparently as firm and hard as a single mass of granite of those dimensions. The outboard bearing of the main shaft is also mounted

on a single block of the same construction. The cost of these foundations was less than the estimate made for the same in first-class brick or stone mason-work.

It has also been used for lining a reservoir of ninety-six thousand gallons capacity, which was blasted into a ledge.

Another great advantage realized in re-enforcing béton with iron, is that the iron overcomes its tendency to check in hardening, within useful limits, however large the surface may be, if the distribution of the iron through the work is made with ordinary good judgment. This is demonstrated in the instance of entire freedom from shrinkage checks in the single section of béton-flooring laid in the drawing-room of the house. Its dimensions are eighteen by thirty-six feet, three and a half inches thick, and after a period of eight years, during six of which it has, in winter, been more or less subjected to unequal strains from the expansion and contraction, caused by changing temperatures, while employed as a transmitting medium of heat for warming the room, there is no trace of a check throughout its whole extent.

The method of heating the house is shown in Fig. 2, where the section exhibits the arrangement of hot-room and heating-flues in the walls and floors.

In the center of the cellar is a heating-chamber, measuring eleven by sixteen feet, and eight feet in height. Within this chamber is placed an ordinary cast-iron heater, of a capacity for burning about three hundred and fifty pounds of coal per day. Openings were made, about twelve inches apart, all around the top of the surrounding walls of the chamber, leading outwardly to the spaces between the first floors and the cellar-ceilings, and also up through the flues within the interior walls, which communicate with the spaces between the second-story floors and ceilings beneath them. Vertical iron pipes, of suitable size, are located so as to connect the open spaces between the cellar-ceilings and first floor with a large, closed trunk, or passage-way, which extends nearly all around the inside of the main wall foundation, under the cellar-floor, and finally terminates in a large flue, which leads directly under and into the heating-chamber.

This comprises about the whole system of arrangements in the construction for warming the house with heat radiated from the floors and interior walls.

Its mode of operation simply consists in the body of warmed air passing from the heating-chamber upward, through the walls and under the floors, and in its passage giving up its surplus heat to the surfaces of these flues. As the air becomes reduced in temperature, it naturally descends through the pipe and trunk passage-ways provided for its return to the heating-chamber, where it is again recharged with heat. It will readily be seen that, by this method, a continuous circulation will be maintained with the same quantity of air; and furthermore, that the velocity of the current will vary with the dif-

ference of temperature of the air when leaving the heating-chamber and when re-entering the heating-chamber.

By this system there are about fifty-five thousand cubic feet of the interior of the house heated by radiation, through about thirty-

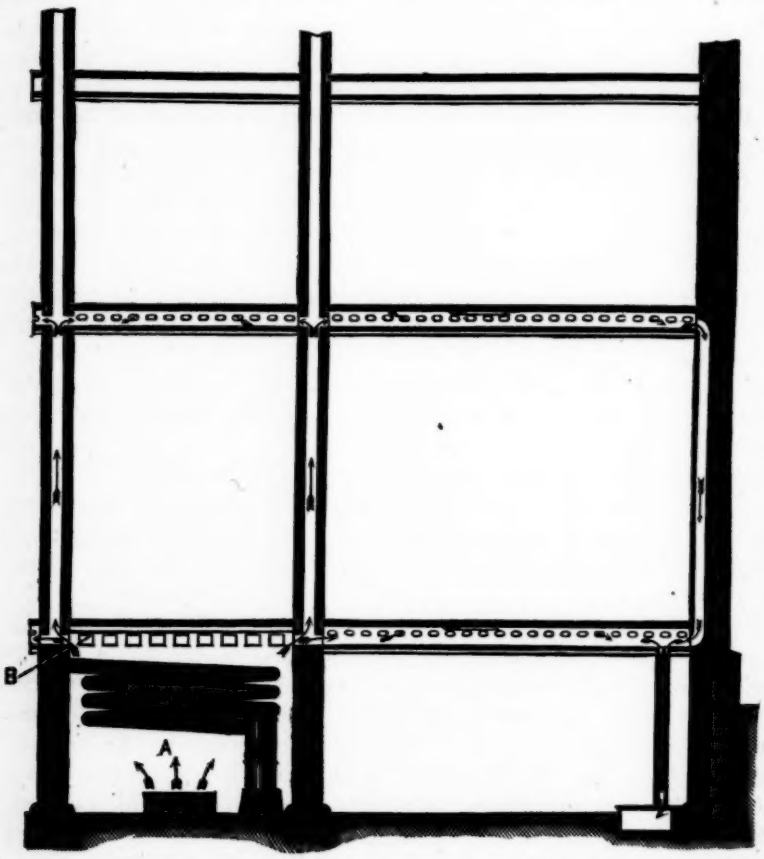

FIG. 2.—SECTION OF HOUSE, SHOWING THE METHOD OF HEATING: A, heating-chamber; B, openings in heating-chamber communicating with flues in the interior walls leading to spaces under the floors. The arrows show the direction taken by the current of air.

five hundred square feet of floor and wall surfaces, and the capacity of the heating-chamber is fourteen hundred cubic feet, so there is one cubic foot of heated air to forty cubic feet in the house.

The temperature of the air in the heating-chamber averages, in very cold weather, 170°, and after delivering its surplus heat to the floors and interior walls, its temperature registers 58° in the flue where it re-enters the heating-chamber for reheating, showing that 112° of heat had been given up and utilized for warming purposes. With ordinary care in managing the furnace, a temperature of 68° can be uniformly maintained on the first floor, and from 60° to 62°

on the second floor, with a consumption of about three hundred and twenty-five pounds of anthracite coal per day in the furnace.

The temperature produced by this system of heating is free from the objectionable variations so common with other modes of heating. The walls and floor form such large heating surfaces that the temperature is uniform in all portions of the rooms, while the air is not vitiated by escaping gases or heated dust, as is universally the case where furnaces or steam-pipes are used for heating.

It is not asserted that its economic results per pound of coal are greater than those claimed for the steam or hot-water systems, but, if the latter were required to make as liberal provision for the renewal of fresh air in the interest of an equally good ventilation, the percentage of useful results per pound of coal from steam or hot water would average no higher than by this method.

The rain-water falling upon the roof passes through two six-inch iron pipes, which are set in the walls, extend across the cellar, and connect with a béton tank in the rear tower, holding five thousand gallons, whose water-level is thirty inches below the level of the roof. This inverted siphon also forms a distributing system to the various points of consumption in the house, through short branch pipes connected with these mains.

There are also two other tanks made of béton, and holding three thousand gallons, situated under the main tank: one of these sustains a head of over twenty feet of water, and has never given any indications of leakage.

In regard to the important factor of cost involved in this system of béton construction, its average for beams, floors, and roofs, including the supporting platforms for laying them down, was a fraction over sixty cents per square foot. This cost also includes the re-enforcing iron beams and rods. The cost of the heavy wall-work, not including cornices, was about twenty-four cents per cubic foot, which includes the cost of plank molds, required for building up the walls. The advantages that contributed most to these economical results were cheap material and cheap labor.

The bulk of the material required for the work abounds in inexhaustible quantities, and is always obtainable at moderate cost. The skill needed consists in a simple knowledge of the right proportions of material, and of its proper manipulation, which can be obtained in a half-day's practice. The most inexperienced laborers can do all the work of the most elaborate béton construction, excepting only the surface-finishing, and this, with all the other work, can be superintended by one competent, experienced builder.

Along with the foregoing data, it may be well to include an account of some experiments that were made to test the heat-enduring qualities of béton. A number of large test-bricks were made of the same proportion of materials used in the construction of the walls,

and, in subjecting them to heat of different intensities to see how much they could withstand before breaking up, there was no perceptible difference observed in the tendency to fracture, whether the bricks were exposed to a gradual or rapid heating. Not one of them broke when subjected to a white heat. Several were heated to a bright-red heat, and then plunged into a bath of cold water. They withstood this test without showing a decidedly damaging fracture, and one of the bricks was exposed to an alternate heating and cooling three times before breaking up.

These results were a surprise, and they suggest the advantage of using such a material for the walls of buildings, as a sure defense against uncontrollable conflagrations. The facts that appear to be established by the line of experiments are:

1. That a system of iron beams re-enforced with béton can be made to sustain weights many times greater than the iron beams alone can bear without re-enforcing.

2. That floors and roofs can be economically made of béton re-enforced with iron rods, capable of sustaining heavier loads, with a less number of supporting beams, than any other system of flooring and roofing, of equal cost, now in use.

3. That the system of re-enforced beams and béton floors affords advantages for a more perfect method of heating buildings uniformly than by the steam or hot-water system.

4. That the sanitary requirements of complete ventilation are plainly within the reach of this system of construction.

5. That it affords a perfect defense against the interior destruction of buildings by fire.

The intrinsic worth of béton construction appears most valuable in furnishing the elements of fire-proof construction, and thus inaugurating a reform in the prevailing system of building based on the principle that safety can be more economically realized through reformation than by exclusive dependence on insurance indemnities for losses by fire. The amount of capital destroyed by fire appears almost fabulous, and has been estimated by insurance authorities to be over one hundred million dollars annually in this country. This enormous estimate takes no cognizance of the losses due to the disturbance of business relations and labor by such enforced interruptions of industry, but the sum of the losses accounted for seems to be enough to awaken an interest in the discovery of some effective remedy for reducing them.

Yet, if the remedy is only to be found in building more thoroughly, its adoption may remain doubtful so long as the hazardous method of building, and the rates for insuring hazardous property, occupy their present relations to each other. Such radical departures from conservative ideas of building as are herein described must necessarily find a slow recognition.

However destructive to the material wealth of the country may be the vast losses of property by fire, they sink completely out of view when compared with the terrible sacrifices of human life that are constantly resulting from unsafe building construction. Against these fearful consequences, humanity can reasonably protest, and claim, for the sake of human welfare, that such structures as hotels, theatres, public schools, and all other places of public resort, shall be made invulnerable to fire.

The writer has heretofore declined to make any public statement concerning the experiments herein described, for the reason that he considered that they ought to undergo thoroughly satisfactory tests of severe weather exposures, and varying temperatures, through a period of time long enough to determine their true and relative value.

In conclusion, it is to be hoped that these experiments may shed enough additional light on the fire-proof building question to make the way easy for reducing re-enforced béton construction to a system, that will deserve public confidence, and ultimately find general adoption.

WAYS OF PRESERVING FOOD.

By Dr. HERMANN KRÄTZER.

THE protein constituents of our animal and vegetable foods, such as albumen, etc., render them in a high degree sensitive to external influences and easily susceptible to decay. For this reason attention has for a considerable time been given to the search for methods of preserving them as long as possible unchanged. Formerly, this matter was left to the housekeeping department; but within the last eighteen or twenty years it has become an object of scientific investigation.

The most common methods of protecting meat, fish, vegetables, and fruits against destruction have been to preserve them in sugar, salt, or vinegar; and the processes of pickling, smoking, drying, pressing, and refrigeration, have been devised for this purpose. Extracts of the essential constituents have also been employed, and forms of compressed meat have been introduced. A number of other special methods of preservation will be described in this article.

A well-known process of securing meat, vegetables, etc., against decay is by canning, which consists in heating the substances so as to drive out the air, and sealing them up while still hot in air-tight vessels. For this purpose they are put into the cans, only a small hole being left in the top of the vessel and exposed to a salt-water bath, in which they are heated to a higher temperature than the boiling-point of pure water, when the can is closed. This method has the advantage

of preserving all the nourishing qualities of the substances and their taste unimpaired. The use of glass and earthen ware jars instead of tin cans is familiar.

A method has been patented in England for preserving meat in gross. The beast is killed, and, after all the blood has run out, is at once skinned and disemboweled. It is then dipped entire into a mixture of 72 per cent alcohol and one per cent of carbolic acid, and after it has dried is laid in a concentrated alcoholic solution of sugar. It is then cut up and packed in casks which are afterward filled with melted fat.

By another English patented process the meat is soaked during from twenty-four to thirty-six hours in a solution of 150 grammes of boric acid, 300 grammes of borax, 155 grammes of common salt, and 53 grammes of saltpeter, which had been previously dissolved in two litres of water, after which it is packed in casks. A practicable method of preparing meat for long transportation is to expose it to a current of refrigerated air till it is stiffened, then sprinkle powdered borax upon it, and put it in a refrigerator-car.

Herr F. Wickersheimer's process employs a solution of 36 grammes of potash, 15 grammes of common salt, and 6 grammes of alum, with three litres of water, which is heated to 122° and added to a second solution of 9 grammes of salicylic acid, 45 grammes of methyl alcohol, and 250 grammes of glycerine; and with this the whole animal is charged.

Kauffmann's method of preparation has been tried in household practice, with satisfaction. The top of a cask is removed carefully so that it can be tightly fitted in again, and a pan of sulphur is put in the bottom of the barrel and set fire to. The top, to which the meat has been hung, is then fitted in. By repeating the fumigation often enough, meat can be kept for a long time even in the summer, without ice, and without imbibing the odor or taste of the sulphur.

The exclusion of the air is sought in the canning processes. The real object is to exclude the germs of decay that are brought in with the air. The same purpose may be effected by filtering the air. To do this, a thickness of cotton between two pieces of linen may be put over the mouth of the jar. The vessel with its contents having been heated to expel the air within, the air that returns upon cooling deposits its germs upon the cotton in passing through it. The vessel may then be tightly closed with parchment-paper.

Among other methods of preserving foods are the familiar ones with sugar, salt, saltpeter, and vinegar. The first three substances act by withdrawing water from the conserves and leaving in place of it their own concentrated solutions, which are unfavorable to the development of germs. To obtain a perfect preservation, the solutions should be in a state of very great concentration and should surround the food-matter on every side. The sugar-process is expensive on ac-

count of the amount of sugar required to make it efficient. Dr. Bersch has suggested a way of cheapening it by adding salicylic acid to the sugar. His directions are to dissolve 100 grammes of sugar and three grammes of salicylic acid in hot water, and to pour the solution, after it has cooled to about 100°, over the fruit to be preserved. If the fruits are wholly covered with the solutions they can be kept in open vessels without changing; but it is best to seal the vessels with salicylic-acid paper (made by dipping common writing-paper into an alcoholic solution of the acid), so as to keep out the dust. Thus prepared, a ten per cent sugar-solution is strong enough for such fruits as cherries, apples, pears, etc., and an eighteen to twenty per cent one for the sweeter fruits. A difficulty in the application of this process arising out of the qualities of salicylic acid as to solubility may be obviated by previously dissolving the acid in glycerine. The old-fashioned way of packing meat in salt and saltpeter is bad, because it takes all the juices from the meats. It is preferable to prepare a brine by heating a kilogramme of salt, 160 grammes of white sugar, and 80 grammes of saltpeter in six litres of water over a gentle fire, and pour the mixture, after it has been cooled, over the meat.

Fruits, cucumbers, and meat, may be preserved for a long time with vinegar, by processes which are too well known to require a close description. Meat is not generally preserved by the direct action of vinegar, but by the vapors of acetic acid. For this purpose the meat is placed on a shelf in a cask, in the bottom of which concentrated vinegar has been poured. The escaping acetic vapors exercise a preservative influence which is effective for a considerable time. The processes of pickling and smoking are so well known that we speak particularly only of a rapid-smoking process, which consists in painting the meat some three or four times with a brush dipped in pyroligneous acid, after which it acquires the taste and properties of well-smoked meat.

The processes of direct drying, which have long been employed with fruits, have more recently been applied to vegetables. By late improvements they have been brought to a degree of perfection in which the freshness, taste, and tenderness of the fruits and greens are well preserved. Potatoes are dried by Casseten, at Lubec, into a light, citron-yellow, gummy, transparent mass, which, when cooked with water and a little salt, regains the color and mealy consistency of the original tuber, and can not be distinguished by its taste from a freshly-cooked potato.

Meat is dried, by the processes of Endemann and others, into a very nourishing food. By Endemann's method, the meat, cut into slices, is placed in a chamber heated to a temperature of about 140°, in which a current of air of the same temperature is kept constantly circulating. If the ventilation is sufficiently active the meat will be dry enough in three hours to be ground up in a mill. The powder,

which has a faint smell of roast meat, is very good, and can be used in the preparation of soups and broths.

The meat-biscuit of Gail Borden is prepared by seething freshly-killed beef with hot water till all the nourishing constituents are extracted. The solution of these constituents is then dried to the consistency of an extract, and this is mixed with flour into a dough which is made into cakes and baked in a moderately hot oven. According to Mr. Borden, five hundred grammes of the biscuit contain as much nutritive matter as two and a half kilogrammes of fresh meat. In a similar way, turnips, celery, spinach, and other vegetables, are dried and compressed in square cakes, which, enveloped in tin-foil, will keep fresh in the market for a very long time.

Other methods of preservation depend on the use of antiseptics. Besides carbolic and salicylic acids, borax, boric acid, boroglycerine, and xanthogenate of potash, may be used in preserving. Aqueous solutions of boric acid and borax are very effective preservatives, for many months, of meats, fish, vegetables, or fruits, which are immersed in them. Pulverized borax is also effective, whether by itself or mixed with pulverized alum and gypsum.

The substance called boroglycerine has recently attracted considerable attention. With it Professor Barff has prepared meat for preservation during long voyages, and has shipped experimental packages of beef across the Atlantic Ocean and back without their undergoing any change. Mr. Russell, President of the English Society of Arts, has also, independently of Professor Barff, found it excellent for the preservation of meat and milk. It promises to come into general use, for its application is without the slightest danger to the healthful or other qualities of the food, and it is very cheap. The "Deutschen Industrie Zeitung" gives the following directions for its preparation: Glycerine is heated to as high a temperature as it will bear without decomposition, and as much crystallized boric acid is added to it as it will dissolve. The usual proportion is 92 parts of glycerine to 62 parts of boric acid. The mixture is then heated to a temperature of about 400°, till after four or five hours the vapor of water ceases to pass from it. The resultant product, after cooling, is boroglycerine, in the form of a yellow, transparent mass, soluble in water and alcohol. It is applied to organic substances in solutions of one part to forty parts of water.

With xanthic acid, Professor Zöllner, of Vienna, has preserved beef and veal, poultry, pigeons, and over-ripe plums. Its operation is the more effective because it is volatile at ordinary temperatures, and a very small proportion of its vapor in the air of a chamber is efficient to prevent all decay.

A preservative salt, patented by a German manufacturer, consists of crystallized boric acid and phosphate of soda, to which a mixture of common salt and saltpeter is added.

We stop, without having yet exhausted the list of possible processes for preserving food. New ones are discovered from time to time, which may prove practically applicable for general use; and many are still in an experimental stage, not yet sufficiently tested or sufficiently perfected to justify recommending them to the public.—*Translated for the Popular Science Monthly from Die Natur.*

INSANITY.

BY ONE WHO HAS BEEN INSANE.

PERHAPS, if some of our most celebrated experts, in cases of insanity, had been, for a while at least, insane themselves, it would have been to the advantage of science. Of some diseases, like malarial fever, or small-pox, a physician can doubtless give a better idea than the patient who has suffered from them; because, these diseases being distinctly physical, the symptoms furnished by the body are generally sufficient data for an accurate diagnosis. But insanity may be said to possess more of a psychological than a physiological character. The brain, being the organ through which the mind communicates with the outside world, can not, if it becomes disordered or diseased, give or receive any trustworthy intelligence. Only the patient himself can know his condition, and he only so far as he can subsequently recall his experiences. Sometimes his recollections are confused and worthless, and at other times they are remarkably vivid. I have been undoubtedly insane twice, the delusions on each occasion continuing for the space of three or four weeks. These attacks occurred several years ago, and were about six or seven months apart. I propose, in this article, to allude to so much of my experience, during the two periods, as may throw some little light upon a subject that has always been as interesting as it is obscure, and that has occupied the attention of some of the ablest intellects in this country and in Europe.

In consequence of overwork, excitement, and mental anxiety, my nervous system had become almost totally prostrated, and I suddenly and without warning lost my reason. Neither my friends nor myself had received any such intimations as led us to apprehend a calamity of that kind. So far as we knew, there had never been any insanity among my ancestors or relatives. During the trial of Guiteau, it may be remembered, the question was raised, to what extent insanity could be regarded as hereditary. A distinction without a difference was drawn between inheriting insanity and inheriting a tendency to become insane. Few persons, perhaps, are born insane; and few are born with consumption. A man whose ancestors have been drunkards is

not born an inebriate. But nobody believes it would be safe for him to tamper with intoxicating liquors, because, in all probability, he has inherited a predisposition to inebriety. And, if one's ancestors have been consumptives, the disease that affected their lungs would, under favorable circumstances, be more apt to affect his than those of one whose ancestors had never had consumption. If a man had an uncle, or an aunt, or a brother, who had suffered from that disease, it would seem to indicate that it was "in the blood." And so, in the same way, as regards insanity. It would not be correct, of course, to say that a person inherited insanity from an uncle or a brother. But the fact that the uncle or the brother had been insane would show that the disease was in the family—in the blood—and one, in such a case, would have good reason to be apprehensive lest he himself might have inherited a predisposition to become insane from the same source whence his relatives had derived their tendency.

The first that I remember of my attack was while I was riding in a railroad-car. It seemed to me that the passengers in the forward part were getting up amateur theatricals. The fact that this did not surprise me, nor appear at all out of place, illustrates one curious feature of insanity, and that is, its close similarity in many respects to *dreaming*. It is well known that the strange phantasmagoria attendant upon most of our dreams never strikes us at the time as at all astonishing, illogical, or contradictory, because the critical faculty in sleep is partially and perhaps wholly dormant. And so also is it in insanity. And as a sound or a touch will suggest or give direction to an ordinary dream, so everything that occurs within the sight or hearing of an insane man affects him in like manner. Also, he has no more control over his words and actions, when the insanity is complete, than a somnambulist. And, when a patient comes to himself, after having been insane, he feels as though he had been having a long and, sometimes, a very unpleasant dream. Some of my delusions were of a frightful character, and resembled a nightmare more than anything else; but more often they were by no means disagreeable. Of course, it seemed strange to me afterward that I could have been carried away by such absurdities. At one time I thought that the end of the world had come, and that the day of judgment was at hand. This was somewhat remarkable, because I had not for years been a believer in the scriptural prophecies relating to those two events. Nor had I any faith in the doctrine that there is a hell of fire; yet, in imagination, I visited that place of torment, and witnessed the tortures of the damned—without, however, getting scorched myself. Some strange conceits, that I had come across in books, occasionally suggested material for my mind to work on. I saw men whose souls I believed had been taken from their bodies, leaving behind the intelligent personal identity—an idea suggested by a character described in Bulwer's "Strange Story." Again, I thought that demons occasion-

ally reanimated human bodies after death; and this fancy I must have got from a dramatic work by Bishop Coxe, entitled "Saul," in which the evil spirit sent to trouble that unfortunate monarch reanimated and took possession of the body of a priest whom Saul had slain. I mention these instances as serving to show the dream-like character of insanity.

I was confined in an asylum, and during the first part of the time I thought I was unjustly imprisoned, I knew not why, and that my friends were not far off, doing all they could to liberate me. I could hear them, as I thought, talking to me from some place not far distant. Many insane patients, with whom I have conversed, while they and I were convalescing, have told me that they also had heard similar voices, and been deceived much in the same way. This is called "false-hearing." Since my recovery I have had several attacks of it, but not to such an extent as to create any delusion. Sometimes after a day's hard work, or after reading or writing too long, I have heard voices that sounded as though they were out-doors, or in an adjoining room, or in the air. I have experimented with them for the purpose of finding out, if possible, how the brain is affected to produce them. They have led me to believe that there is a great deal more "unconscious cerebration" going on in every man's brain than any one is aware of. While listening to these voices, and conscious all the while of the fact that they were purely imaginary, I have heard remarks that astonished me! What was this but the mind surprising itself by its own communications? I have heard long conversations at such times, and when, for the sake of experiment, I have for the moment treated them as realities, I have received replies that staggered me for the time being, and almost led me to believe some intelligent being was talking to me. There can be no doubt that there have been many people who, without knowing it, have been victims of false hearing, and have honestly thought they were hearing the voices of their disembodied friends, while in fact they were being deceived by an unconscious mental action going on in a disordered brain.

The question, "What is insanity?" will probably never be fully and satisfactorily answered; and one reason for this may be because there are so many different kinds. One kind makes the patient lively and hopeful: he believes himself a king, or immensely wealthy; and he is full of the wildest projects. Another kind of insanity is directly the reverse in its characteristics; it is called melancholia, and often sinks the patient in the depths of despair. Then there is softening of the brain, that ends in dementia, or total absence of intelligence, so that the patient does not know enough to eat or drink, although his body may be apparently in a healthy condition. But, generally speaking, insanity may be said to be a state of delusion in which the mental faculties, to which it would be necessary to appeal in order to

dispel the delusion, are so paralyzed or diseased that they can not be exercised. A few years ago, during the trial of an insane man in Chicago, it was asked whether there could be, strictly speaking, such a condition as partial insanity—that is, whether a man could be perfectly sane and responsible as regards all subjects except one or two. A very celebrated physician endeavored to maintain that it was impossible, because, he said, if one part of the brain was diseased, the whole organ, being in sympathy with that part, would be diseased also. It seems to me that, practically, this physician was mistaken. If the brain is the organ of the mind, there seems no reason why, notwithstanding one portion of that organ may be in an abnormal state, the other parts may not perform their functions well enough. I have certainly seen insane men whose opinions in reference to certain subjects it would be safer to trust than those of some men that have never been suspected of insanity. The question of responsibility is, of course, what gives insanity, from a legal view-point, its chief interest. It is certainly a mistaken idea that no insane person is responsible. It does not obtain in the asylums, at any rate; for discipline is very often maintained there by a system of rewards and punishments. If a patient misbehaves, he is informed that a repetition of his offense will put him back in some ward where his surroundings will not be so pleasant. This threat is seldom without avail, especially if the patient has once already had an experience of the penalty. This would seem to show that he knows good from evil, and has self-control enough to restrain himself from wrong-doing. There are some insane patients, though, of course, that have passed beyond the possibility of all self-control. It is plainly impossible to furnish any general rule by which to decide when a man is responsible and when not.

Insanity does not change a person's character so much as is usually believed. A distinguished English physician has said that, if there be anything in this world that is immutable, it is character. We meet with illustrations of the truth of this assertion almost every day. "Conversion" is believed, by many excellent church-people, to work a complete change for the better in a man's moral nature. But has any one ever seen a mean, close-fisted, narrow-minded man become, in consequence of conversion, liberal and generous? I trow not; and so even insanity seldom alters a man's nature much. For instance, the insane man may imagine people are plotting to kill him; he fancies he hears threats, and thinks he sees motions to carry them into execution. Now, if he be naturally a timid man, and a non-combatant, he will run, and try to escape; but if he is courageous by nature, and inclined to fight, he will act just as he would were all the circumstances really just as his disordered imagination pictures them. Compare the number of murders committed by insane men with those committed by men under the influence of alcohol, and the latter, in

proportion, will be found to be greatly in excess. For my own part, I would sooner trust my life with an insane man than with one whose brain has been inflamed by over-indulgence in the liquors sold in the saloons and grog-shops. Before a person becomes insane there are two symptoms that almost invariably manifest themselves, insomnia and constipation. All the testimony I have been able to collect upon the subject goes to show this; and I have made very extensive inquiries. There has never been a single case brought to my notice, where the patient's mind was much drawn to any one subject, that it did not, to a greater or less extent, prevent his sleeping, and always enough to excite the attention of those about him. For my own part, although I believed Guiteau to be a "cranky" individual, of very peculiar mental characteristics, I never thought him in a sufficiently abnormal condition to be called insane, and principally for this reason, that with all the intensity of his purpose to shoot President Garfield, and notwithstanding the "pressure" he alleged that he felt upon his mind, he was never known to lose a night's rest. He himself said that he always slept well. Now, an insane man, in the condition which Guiteau wished to make the world believe he was, would not have slept well. He would have been up and down in his room all night, and would have been a nuisance to any one trying to sleep in an adjoining apartment. Nor did Guiteau suffer from constipation. The absence of either of these symptoms would have been sufficient to occasion distrust as to his insanity; but the lack of both, to my mind at least, furnished conclusive evidence that he was a responsible man.

Before concluding this article, I wish to say a few words in behalf of a certain class of insane patients that, perhaps more than any others, deserve the sympathies of the public.

When I was convalescent, in the asylum, I attended an evening card-party, given in one of the pleasantest wards, for the amusement of those patients that were well enough to appreciate and enjoy such an occasion. I met a lady, a patient, who had been in the asylum three years. Although I could see that she was somewhat flighty, yet in all other respects she was quite an intelligent person. She told me that she had left at home her daughter, an only child, about fourteen years old, whom she had not seen in all that time. This lady's husband had virtually put her in prison, and had never taken the pains to call on her himself oftener than once a year, and had never allowed her daughter to visit her. Tears stood in the poor woman's eyes as she told me these things, and I had no reason to believe that she was deceiving either herself or me. And upon inquiry I found that her case was not an exceptional one. There are mothers confined in all our asylums, as there were in the institution where I was, who, while they are insane enough to warrant their being put under restraint, are yet sufficiently intelligent to be sensible of their condition, and, like the lady I have alluded to, be overwhelmed by the thought that they

are in a hopelessly helpless condition, and may be kept imprisoned thus for years, or even for life, away from their kindred and friends, and from the little ones for whom their hearts yearn with an intensity that no human being can appreciate, except some mother that has lost a child. This lady said she had known such patients, when talking about the little children from whom they had been separated, to sob and moan for hours at a time. But the law is inexorable. It says that a husband may confine his wife in an asylum if he can prove that she is insane—and that is a very comprehensive word. In some States the certificates of two physicians will accomplish this purpose; and, when once a patient is shut up in a ward, there is no deliverance that can be depended upon, as I shall presently proceed to show. But not only do the women suffer in this way, for there are men whose affections are as keen and as strong as those of any woman, who long to be with their boys and girls, to see them growing to manhood and womanhood, but who know neither the day nor the hour when that longing shall be gratified.

In some of our asylums, if not in all, there is a disinclination on the part of the superintendent to take the responsibility of discharging a patient, even when cured. One superintendent explained it to me in this way: "There is," he said, "no certain way of knowing whether a patient is thoroughly cured. Now, if I discharge one such, while his friends do not wish him to be sent away, and he subsequently becomes insane again, I am held responsible, and it tells against my reputation, and, in some cases, I may be obliged to pay the expense of getting the patient back again into the asylum. For that reason," he continued, "I never like to discharge any one until his friends call for him. I keep them informed of his condition, and leave it to them to decide when they will take him away."

But some one will say, there is a Board of Charities or some such arrangement by which the asylums are visited and such patients liberated. In most cases such visitors do not visit in the way the public imagines or the law requires. I have yet to learn of a case of deliverance effected by any such board. They go to the asylum, glance through the "crack wards," and then partake of a sumptuous dinner got up for their benefit by the superintendent, and that is all. But as to any careful search and investigation, to see whether there are not patients whose conditions might not be improved, or whose sufferings alleviated, I never heard of anything of the sort, nor have I ever talked with any one that had. Now, I am not saying that superintendents are cruel, nor that they do not do their duty. I am simply pointing out a system that affords every facility for the perpetration of the grossest and most outrageous injustice; and I leave it to the public to say whether any such system ever existed long anywhere without suffering the perversions which it seemed to invite. Some way should be devised—and a legal enactment would be the best remedy—by

which those who confine, or are instrumental in confining, persons that have children, should be compelled to see that the children are brought, a certain number of times every year, to visit the parent thus confined. Again, patients should have greater freedom in communicating with the outside world. As it is, every letter written by a patient is carefully read by the superintendent or some officer; now, suppose a man is unjustly confined, and that the superintendent is an accessory to this false imprisonment. What opportunity would such an unfortunate prisoner have to obtain his freedom? The superintendent can prevent any letter going out that contains any reflections upon himself or the institution in his care. Should friends wish to see such a patient, all the superintendent need do is to say that he can not permit an interview, because the patient is excitable or sick—any such excuse will do. It is always against rules for a patient to address visitors unless they come to see him particularly. But suppose a patient was successful in laying before a stranger a case of injustice—what then? Why, the superintendent can say that the patient did not know what he was talking about, and that would end the matter with ninety-nine people out of a hundred, for every one knows how humiliating it is to appear to be deceived by an insane person!

Let the reader remember that I am not publishing this to bring a railing accusation against asylums or superintendents. While I was confined I was treated like a gentleman, and was shown every consideration by the superintendent and all the officers. I do not believe that in the institution where I was a case of unjust imprisonment could possibly occur while the present superintendent is in charge. What I wish to demonstrate is that the system *invites abuses* by making it so easy for an unprincipled superintendent to act in collusion with an unprincipled outside party, where there are financial or other temptations to deprive some innocent man or woman of his or her personal liberty. It is enough to say there is the writ of *habeas corpus;* but how is an unfortunate person in such a case to inform a lawyer that he wants such a writ issued in his behalf? And does any one believe that, if the Board of Visitors in New York could have been relied upon to do their duty thoroughly, any such outrage as that upon Mr. Silkman could ever have been perpetrated, or that it would have ever been attempted?

The "cottage system" has been spoken of as one means of rendering asylum-life pleasanter. But, although that system is better for the patients, it is not nearly so convenient for the officers; and, as these latter have always more to say on the subject than the patients, it is not likely that the cottage plan will ever be very extensively adopted. It is much easier to manage an institution where everybody and everything are in one large building than where they are scattered in different houses. Nevertheless if patients could have more of out-door life, could move about in a flower-garden and breathe the fresh air and

bask in the sunshine, more than they possibly can while they are penned up in wards, they would improve mentally and physically more rapidly than they do. I do not not know of any more depressing influence within the range of the possibilities than that which settles upon one who has recovered his senses in an asylum, and is retained there until he recovers his health! The possibility of recovering one's health, surrounded by insane people, is what I have always doubted, and why I insisted upon leaving the asylum as soon as I did; and I never look upon such an institution without a heart-felt pang for the many sad and wretched beings I know it must contain; and with this comes the still more horrible thought that there may possibly be among them some who, in all justice and right, should be as free as I myself.

THE LITTLE MISSOURI BAD LANDS.

By Professor T. H. McBRIDE.

II.

"Knew you what silence was before?
Here is no startle of dreaming bird
That sings in his sleep or strives to sing;
Here is no sough of branches stirred,
Nor noise of any living thing."—Lowell.

HOWEVER interesting the Bad Lands may be in their scenery and in their conditions purely physical, it is only when we consider them in their relation to life and its progress on the earth that they become most attractive, most engaging.

To describe the present flora and especially the fauna of this region would require no very long chapter, and yet the list of species would be longer than some might suspect. Where erosion less interrupted by the fires has been allowed to do its perfect work, there are level areas of considerable extent sparsely covered with short grass, on which the prong-horn, the elk, the deer, and the big-horn sheep, have been wont to graze. The valleys, and even the flat tops of the buttes in May, are said to abound with flowers. Cottonwood-groves occur along the banks of the river, and occasionally a thicket of low box-elders, plums, and various kinds of thorny shrubs, divides with the sage-brush the occupancy of some sheltered ravine; while up the northern faces of some of the higher and more sloping buttes, where the snow of winter lingers longest, low, ragged cedars creep in straggling file. But, where the fires have done their part, the desolation is extreme. Even the vegetation which the spring-time may have brought seems to vanish from the earth, the precipitated alkali whitens the valleys, and from all the naked hills comes up a glare of dazzling

light as from a desert absolute. Far as you can look or listen there comes not the faintest sign or whisper of living thing. No bird visits those forgotten hills, no insect stirs about your feet or beats with humming wings the air; the very wind is silent, and from the glowing buttes, as from a furnace, the heated atmosphere rises in shimmering columns. It seems as if it had never rained, or, if it has rained, it seems as though it would never rain again. Here is the trail by which, in 1863, passed General Sully and his train when all these hill-tops were alive with hostile Sioux. The Indians are long since gone, but the trail remains unchanged, and can be easily followed after a lapse of twenty years. Yonder, along that other trail still so clearly visible over the distant buttes, went Custer and his band when they marched away to the west and disappeared from human sight forever. The climate is an arid one, and the process of erosion slow. Looking out over the landscape as we now see it, none would imagine that all this territory was at one time favored with a climate perhaps nearly semi-tropical, that over all this wide area were waving forests of perpetual green, stretching away to the north, south, east, and west, almost to the limits of the so-called "Plains." Yet such is the case, and this complete transition from the wealth of primeval woods to the poverty of semi-desert has been brought about not by the devastation of short-sighted man, but by the orderly procedure of all those indefinite forces which for convenient description men sum up as Nature. The evidence of this transition is not far to seek. Scattered over the grassy low-lands, crowning many an isolated pillar of sandstone or clay, lying here and there on all the high hills, are remnants of gigantic trees, remnants more or less perfectly silicified, stumps, boles, and branches. In some localities these "petrified stumps" cover the whole face of

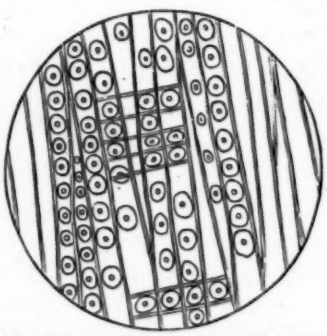

FIG. 1.—LONGITUDINAL SECTION OF SILICIFIED WOOD, × 150.

FIG. 2.—MICROSCOPIC SECTION OF THE WOOD OF THE COMMON LARCH, CUT IN THE LONG DIRECTION OF THE FIBERS.

the country, and scores have been carried away on flat-cars to decorate the lawns of those able to pay freight on such unwieldy "curiosities." Scientists are frequently disposed to doubt petrifactions, and are often compelled to disappoint popular expectation in regard to forms most

fairly outlined; but that these stumps and logs and splinters have been wood there can be no possible doubt. Our microscope settles the question once for all by revealing the very form and markings of the original wood-cells now replaced by silex. In Fig. 1 we have the microscopic view of a section taken from a log lying on the summit of one of the buttes. The medullary rays are plainly seen, as well as wood-cells bearing series of peculiar concentric circles, which every botanist instantly recognizes as characteristic of the *Coniferæ*, the cone-bearing trees, pines, cedars, firs, sequoias, so that we may not only safely pronounce the petrifaction on the hill-top a fossil log, but we have determined without doubt the vegetable order to which it belongs. For the silicifying of such masses of organic material long submergence was doubtless necessary, but to which of the beds of the series exposed these relics belong it is difficult to determine. Such fossils come to light only by erosion, and erosion leaves them always at the lowest levels.

But these are not the only evidence of a former vegetable life very different from that now prevalent in the Bad Lands. All these beds

FIG. 3.—PLATANUS NOBILIS (Newberry) × ½.

FIG. 4.—POPULUS CUNEATA (Newberry).

of lignite, said to exceed in area all the other coal-fields of the world, are of undoubted vegetable origin. Knowing what we do about coal in general, we can conceive of no other history for them, and although we find in these American beds no such veritable logs as characterize the *braun-kohle* of Northern Europe, yet the presence in the lignite of

bits of carbonized wood, twigs, and bark, leaves no doubt as to the character of the primal vegetation.

But it is in the beds immediately associated with the coal that we find the most indubitable evidence at once of the presence and character of the former flora. Here, in strata of sand and clay, lie most beautiful impressions of the leaves of both deciduous and coniferous trees. We may say fossil leaves, but this is hardly the correct description, since we have preserved to us not a vestige of the original leaf, but simply a mold left in the imbedding clay, as the matter of the leaf disappeared. In fortunate cases, therefore, we have both the upper and lower surfaces of the leaf exhibited, and these impressions are perfect, so that experienced observers can determine, not the order only, but the genus, often the very species and variety, of the tree from which a given leaf has fallen! This seems astonishing to the

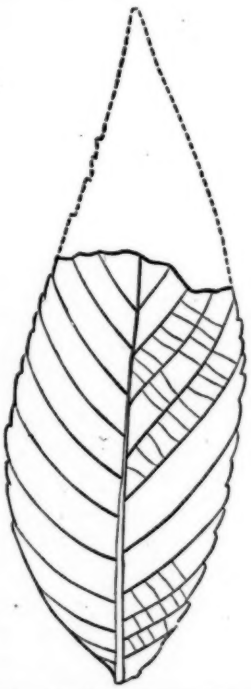

FIG. 5.—JUGLANS WOODIANA (Heer).

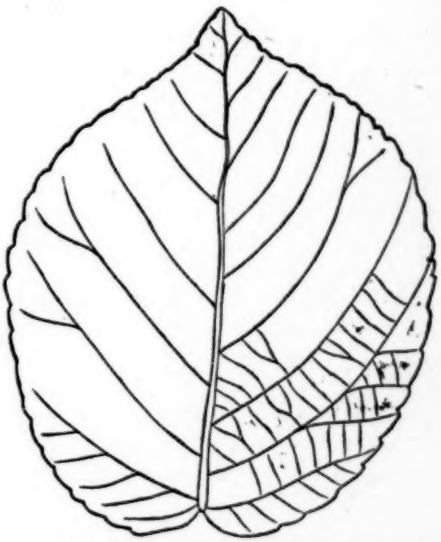

FIG. 6.—CORYLUS GRANDIFOLIA (Newberry).

ordinary student or analyst of flowers, or to him who notes the great variety of form and feature which the leaves of a single tree present —a box-elder, for instance—but fails to see the hidden lines which betray relationship. But such men as Goeppert, Heer, Saporta, and our own Lesquereux, like Tischendorf among the MSS., have a vision and an experience not possessed by many, a "special insight," Professor Lesquereux says, which, in presence of a single organ, a single leaf,

can conjure forth from the dim ages past the plant entire; and men like Gray and Hooker, while acknowledging themselves not possessed of similar divining power, admit the veracity of the results obtained. I have said a leaf, an organ, sometimes a fragment, is sufficient, and that which to the ordinary observer is wholly enigmatical becomes to the paleophytologist a revelation. "These are the scattered fragments of the old book of Nature. When one sets himself to decipher them, he very soon forgets the singularity of the characters and the poor condition of the pages. Thought rises, ideas develop, the manuscript

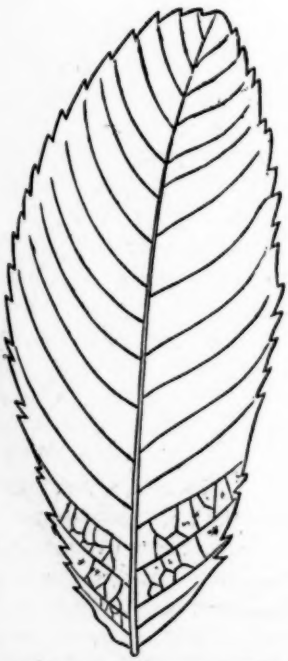

FIG. 7.—CARPINUS BETULOIDES (Ung)?

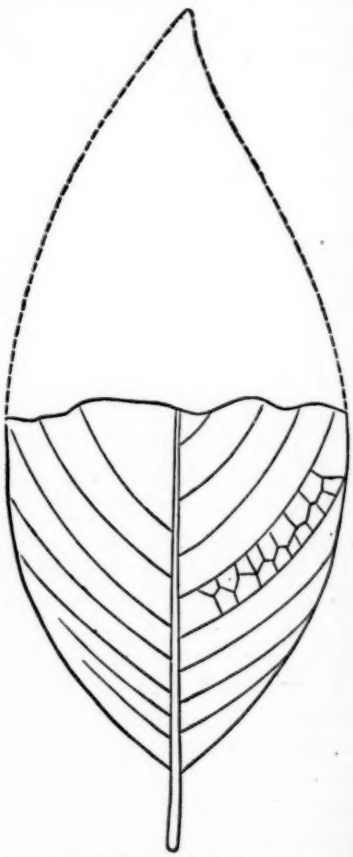

FIG. 8.—PERSEA —— ? × ½.

unrolls. It is the tomb that speaks and delivers up its secret."* We are reminded of the prophetess of classic fable, who wrote the burden of her prophecy on forest-leaves, and then committed the precious pages to the winds. He who would find the inspiration of her song must have the wit to rearrange.

* Saporta, "Monde des plantes avant l'apparition de l'homme."

Of these leaf-prints the finest specimens collected in the Bad Lands come from strata which have been baked by the burning coal. This burned material furnishes a matrix of sufficient hardness to preserve perfectly the mold and to endure the stroke of the hammer which brings to light the hidden image, and so the life-history of Dakota, like the history of some of the old Oriental monarchies, is revealed by the cleaving of burned bricks.

So far as I am informed, no systematic search for these fossil leaves has ever been made. They occur on the surface in isolated spots, and different localities furnish different as well as similar forms. The baking to which the fossil-bearing beds have been subjected has, in a measure, obliterated the distinction of strata, so that it is difficult in any case to determine the exact horizon, or to say whether all the leaves are from about the same level, and hence contemporaneous; it suffices our purpose to know that they are nearly so. At all events, in strata such as these, and as geology reckons time, no intervals have been very great, and we may omit discussion of the relative age of the leaves, and consider immediately their kinds and meaning. We have represented, in Figs. 3–12, leaves of the following genera: *Platanus, Populus, Juglans, Corylus, Carpinus, Persea, Ficus, Sequoia, Cornus.** These names are all familiar, although we are not accustomed to see them grouped together. *Platanus* is represented throughout the northern Mississippi Valley by the sycamore, frequenting the water-courses and rocky banks, and often attaining grand dimensions. Two species of the genus occur in California, two in Mexico, and one in the far Levant. *Populus* we know from our aspens, balm of Gilead, and more than all by the cottonwood—a prairie-tree—abundant along our Western rivers, and following the Missouri and its tributaries to the very foot-hills of the Rocky Mountains. These trees all secrete about their buds more or less of fragrant wax, and possibly from the tiny pits seen at the base of the leaf of *P. glandulifera* exuded some such balsamic gum which spread and polished the upper surface of the young leaves. Of *Corylus* and *Carpinus* little need be said. The hazels and hornbeams are sufficiently well known as characteristic of north temperate forests everywhere. The genus *Juglans* we know from our invaluable walnut, once common throughout the Eastern United States. A single species is found also in Asia Minor and Europe. *Cornus*, the dogwood, has some northern species. But the three remaining genera are more interesting. *Persea* is a laurel, and laurels are especially tropical plants, extending in hardier forms as evergreens into the sheltered or milder parts of the temperate regions. This particular genus extends along the Atlantic coast from Delaware southward, and is abundant in the West Indies. *Ficus* is also a tropical genus, or, at least, occurs in warm climates only, as in Florida, South America, around the Medi-

* For the identification of these leaves, except one or two, I am indebted to Professor Lesquereux.

terranean, in India, in Java; while *Sequoia* is limited to the mountains of California, and is to us best known through the "Big Trees" of the Mariposa.

All these genera, belonging to so many different orders, leave no doubt that the vegetation of the times when these leaves were green was abundant and varied. We may be sure that the genera mentioned

FIG. 10.—SEQUOIA DISTICHA (Heer).

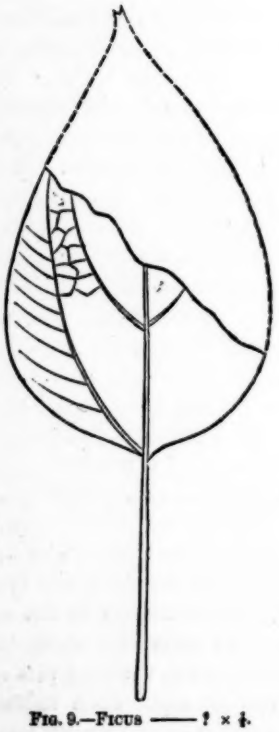

FIG. 9.—FICUS —— ? × ¼.

FIG. 11.—POPULUS GLANDULIFERA (Heer), *a* = glands.

are only a few, a very few, of those to be found, that these were surrounded by their congeners and by a multitude of other and different forms, whose remains man has yet to see and understand. North Dakota was once, if not repeatedly, a land of forests.

But what a strange association of leaves we have here!—the flora of Florida, the flora of California, and the flora of our Northern woods. As we collect the leaves, we find *Sequoia* associated with *Juglans*, *Persea* and *Ficus* lie side by side, *Populus* and *Platanus* seem to affiliate, although *Populus* has of all the widest distribution. In the beds where they are found these leaves lie flat and smooth. Preserved just where they fell, they seem, as they lost hold upon the parent tree, to have settled once for all into quiet waters. They have never been much tossed by winds nor rolled by currents, and hence can not be said to indicate that these differing genera represent different altitudes. Be-

sides, the strata have evidently never been disturbed in such a way as to afford any great variety of altitude in this locality. We are therefore shut up to the conclusion that, at the time these leaves were green, a climate prevailed very different from any now known in the same latitude anywhere in North America. The climate must have been warm and equable. Indeed, that the climate, not of Dakota only, but of the whole northern hemisphere, was at one time far milder than now seems proved, for leaves such as these of which we speak have been found in Greenland and many other circumpolar lands. What may have been the prime cause of this former high temperature in high latitudes we leave students of physical geography and surface geology to decide, but we may say this: the warm and equable climates of the world are maritime, or characteristic of islands, as the climate of Italy or the Grecian Archipelago. That a large body of fresh water may work wonders in temperature and amount of moisture, is to us a familiar fact witnessed by the climate of the peninsula of Michigan.

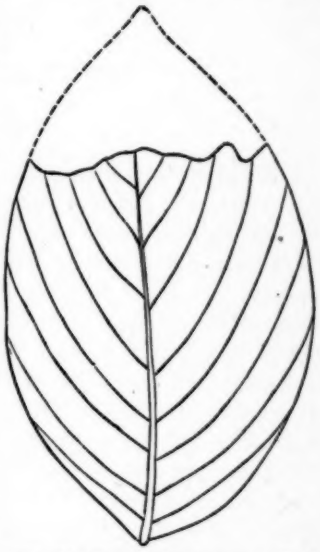

FIG. 12.—CORNUS RHAMNIFOLIA (O. Weber).

And so, to meet the requisite climatic conditions suggested by these few leaves, we are ready to accept without doubt the statements of men who from their study of the topography of the Bad Lands declare the whole region to have been, perhaps again and again, the bed of a wide-spread inland lake or sea. On the shores and islands of this Mediterranean of the Western world stood the forests primeval whose foliage has come down to us like the sad memory of better days.

As one looks upon these fairly outlined relics of a long-forgotten age, he may catch glimpses of landscapes in presence of which all the bleakness and barrenness of the present disappear. Instead of sterile hills and buttes, far stretches the quiet sea, unvexed by storms, but filled with happy islands like the "Islands of the Blest." Over the islands the laurel blooms, abundant fig-trees spread their dense and shining foliage, and send down aërial roots in thickets impenetrable. Along the curving shores the bending willows sweep the water's surface, while hard by stands the broad-leaved plane-tree and the feathery elm, and farther back the hazel and its kindred oak. The poplar shakes its shining leaves and fills the air with fragrance. Over the cornel and the hornbeam creeps the vine, and high above all, walling the horizon like the cryptomeria in the forests of Japan, sequoias, magnificent se-

quoias, whose skeletons now lie white like other skeletons on the hills, lift their tufted branches. The forest-trees fall in natural decay, the mirror waters sleep in peace, while the centuries of the early Tertiary come and go.

FACULÆ AND SUN-SPOTS.

By HENRY A. SMITH.

THE sun when examined with a suitable telescope, properly adjusted as to the power used, exhibits, scattered over its disk, great faculæ waves, which are elevated portions of its surface, and are composed of luminous matter which has extended through its denser atmosphere. In order that these waves may be seen, it is requisite that they attain a height of at least forty-five times that of the Himalayas. Their appearance is very rare in polar regions, but very abundant in the close neighborhood of spots; in fact, they generally precede the formation of a spot. The faculæ, at a distance from the spots, change somewhat slowly, remaining for several days without much variation in their appearance. But it is quite otherwise near a spot, for here these waves change with a rapidity which renders it exceedingly difficult to make a draft of them. Movements not less than one thousand miles in an hour are not uncommon. The faculæ are generally round, though sometimes they appear in long strips of light. When they take the shape of a wreath, a group of spots quite soon appears, as a rule. With the discovery of solar spots may be said to have commenced our knowledge of the physical condition of the sun. Kepler was of the opinion that, in lines 441 and 454 of Virgil's first "Georgic," the solar spots were referred to. We also find in the annals of the Chinese, made many centuries ago, that spots were observed by the unaided eye, and in the year 807 an exceedingly large spot was seen for eight days. A solar spot consists, in the main, of two parts —the central part, called the umbra, surrounded by a less dark portion called the penumbra; and, as Professor Young has said, "The appearance is as if the umbra were a hole, and the penumbra filaments overhung and partly shaded it from our view, like bushes at the mouth of a cavern"; the umbra being a depression below the photosphere, filled with less luminous matter, while the penumbra may be seen around the edges.

It is observed that the spot, when half through its existence, is circular in shape, but, as it approaches disruption, it is subject to great change, sudden and violent. Respecting the average life of a spot, we may say it is from two to three months. The spot, however, observed in 1840 and 1841 lasted eighteen months, the longest time on record. Again, some may last but a few hours, being suddenly formed and

rapidly shattered in pieces. They appear generally in groups, though single spots are seen at times. When a large one is divided into parts, they seem to repel one another, and move away in various directions with great velocity; it is not uncommon that this separation is equal to one thousand miles in an hour. Respecting what is sometimes seen about or crossing spots, we call attention to the simultaneous observations of Mr. Carrington and Mr. Hodgson upon two luminous objects, resembling in shape two new moons, each 8,000 miles in length and 2,000 miles wide: these, separated by at least 12,000 miles, came instantly into view at the edge of a large sun-spot, with a brightness several times greater than the surrounding photosphere, then passed eastward over the spot, and disappeared in about five minutes, having gone not less than 36,000 miles. In no way did the disturbance apparently affect the shape of the spot (passing probably above it). On the following evening a great magnetic storm and aurora were decidedly manifest, and there can be little doubt that they were connected with the event seen in the sun the day preceding. Likewise we know that a great solar storm is in progress when our northern heavens are so beautifully illuminated with the northern light. As to the formation of some spots they have been very slow, requiring no small amount of time after the disappearance of the facular waves; again, as stated, some come and go in a few hours, and assume in some cases huge dimensions as compared with any one thing on the earth. A single spot has measured from 40,000 to 50,000 miles in diameter, in which, as will be readily seen, we could put our earth for a standing point of observation, and note how the vast facular waves roll and leap about the edge of the spot, and also how the metallic rain is formed from the warmer portions of the sun. In June, 1843, a solar spot remained a week visible to the naked eye, having a diameter of about 77,000 miles; and in 1837 a cluster of spots covered an area of nearly 4,000,000,000 square miles. When we call to mind that the smallest spot which can be seen with the most powerful telescope must have an area of about 50,000 miles, we can readily see how large a spot must be in order to be visible to the unaided eye. Pasteroff, in 1828, measured a spot whose umbra had an extent four times greater than the earth's surface. In August, 1858, a spot was measured by Newall, and it had a diameter of 58,000 miles—more, as you will see, than seven times the diameter of the earth. The largest spot that has ever been known to astronomy was no less in diameter than 153,500 miles, so that across this you could have placed side by side eighteen globes as large as the earth; and, when the depth of this cavity is considered mathematically, the result shows that probably not less than one hundred globes the size of our earth would have been requisite to bring it up to the photosphere of the sun. So numerous have been the observations and measurements, that any attempt to present them all would require many pages.

INSECTS AND DISEASE—MOSQUITOES AND MALARIA.*

By Professor A. F. A. KING, M. D.

THE animalcular, or insect, origin of disease is not a new idea. It was suggested by Linnæus, by Kircher, and by Nyander, but gained little ground. It received a new impetus after the publications of Ehrenberg on the Infusoria. Later, it received attention in Bradley's work on "The Plague of Marseilles," in Dr. Drake's books on "Epidemic Cholera" and on "The Topography and Diseases of the Mississippi Valley," as well as in Sir Henry Holland's "Medical Notes," and other works.

More recently the researches of Dr. Patrick Manson in China, Dr. Bancroft in Australia, Dr. J. R. Lewis in India, and Dr. Sonsino in Egypt, have tended to show that the mosquito "acts as the intermediary host of *Filaria sanguinis hominis*," and is thus indirectly instrumental in the production of chyluria, elephantiasis, lymph-scrotum, etc. (London "Medical Times and Gazette," January 12, 1878, p. 69; September 7, 1878, p. 275; December 28, 1878, p. 731; and June 4, 1881, p. 615).

Still later, M. le Dr. Ch. Finlay has hypothetically considered the mosquito an agent of transmission of yellow fever ("El mosquito hipoteticamente considerado como agente de transmission de la fiebre amarilla," Havana, 1881; and "Pathogonia de la fiebre amarilla," 1882). These papers were communicated to l'Académie royale des sciences médicales, physiques et naturelles at the dates mentioned. A review of them, by Dr. A. Corre, appears in the "Archives de méd. Navale," tome xxxix, pp. 67–70, 1883, Paris. (See also "Lancet," 1878, i, p. 69.)

Viewed in the light of our modern "germ theory" of disease, the punctures of proboscidian insects, like those of Pasteur's needles, deserve consideration, as probable means by which bacteria and other germs may be inoculated into human bodies, so as to infect the blood and give rise to specific fevers. It has long ago been demonstrated that "malignant pustule" is produced in man by the bite of a fly ("British Medical Journal," January 24, 1863, p. 239). Dr. Budd, in the article just quoted, refers to the greater frequency of this disease in hot, dry summers where insect life is active and teeming; and this, he thinks, would go far to explain the greater frequency of the malignant pustule in Burgundy than in England and the north of France,

* Abstract of a paper on "The Prevention of Malarial Disease, illustrating, *inter alia*, the Conservative Function of Ague," read before the Philosophical Society of Washington, February 10, 1882. For another paper, on "The Conservative Design of Organic Disease," see this journal for June, 1875.

as also its greater frequency in Siberia and Lapland, where insects of the mosquito tribe are the great pest of the traveler. In Lapland the popular belief was long ago universal that the disease was caused by a peculiar insect, which suddenly descended from the air, and as suddenly disappeared. In the London "Times" (1860) it is reported that four hundred persons lost their lives in the south of Russia and in the province of Kiev from the sting of a "venomous fly" imported from Asia, the same fly having made its appearance there on another occasion, sixty or seventy years before. Virchow, who has made malignant pustule a special study, says: "Most probably, insects with piercing probosces effect the inoculation, such as gadflies (Bremse); but flies which make no wound may also implant the poison on the skin by their soiled wings and feet." The bites of these same flies may be generally harmless; they have no venomous power of their own, but only convey poison from sources of infection to man and animals.

Furthermore, when it is remembered that disease-producing bacteric germs are so minute that a million may rest on the head of a pin, and that the smallest puncture of the finest needle-point (as in Pasteur's experiments with chicken-cholera), when charged with an atom of infecting matter, may be sufficient to infect the body with the septic matter, it scarcely seems possible to ignore any longer the punctures of mosquitoes and other proboscidian insects as possible sources of both infection and contagion. With our present knowledge of the "germ theory" one would hardly dare, even once, to plunge an inoculating needle into the blood of a yellow-fever or typhus-fever patient, whether living and comatose or recently dead, and then withdraw it and plunge it into his own blood or the blood of other persons, yet this is exactly what the mosquito is doing in nearly every yellow-fever epidemic, and what, perhaps, the flea is doing in the filthy jails and ships infested with typhus. In the yellow-fever instance, it is to be noted, also, that the spread of the disease ceases with frost; so also do the peregrinations of the mosquito.

In this paper, however, my chief design is to present what facts I may be able in support of the mosquital origin of malarial disease—in fact, of ague. And, while the data to be presented can not be held to prove the theory, they may go so far as to initiate and encourage experiments and observations by which the truth or fallacy of the views held may be demonstrated, which, either way, will be a step in the line of progress. It is scarcely necessary to premise that other—nay, all—insects that infest and wound the human body may share in the guilt that will here be charged, in particular, to the *culex;* and so, of course, other diseases than ague, yellow fever, etc., may possibly have a similar history. Be it noted *en passant* that, so far back as 1848, Dr. Josiah Nott, of Mobile, Alabama, published a lengthy essay on yellow fever, in which he maintained the insect origin of that disease, and also suggested the "mosquito of the lowlands"

as a probable cause of malarial fever, in place of the marsh-vapors of Lanscisci ("New Orleans Medical and Surgical Journal," vol. iv, pp. 563–601, 1848). And, even before his time, I find that a paper on the "Mosquital Origin of Malarial Disease" was published by Dr. John Crawford in a periodical known as the "Baltimore Observer," 1807, no copy of which I have yet been able to get hold of.

I now propose to present a series of facts—some of the best known and most generally established facts—with regard to the so-called "malarial poison," and to show how they may be explicable by the supposition that the mosquito is the real source of disease, rather than the inhalation or cutaneous absorption of a marsh-vapor. These facts are, briefly, as follows: *

1. "Malaria affects, by preference, low and moist localities"—in fact, swamps, fens, jungles, marshes, etc. This statement no one will dispute. Conformably with it we find the mosquito does the same. The female lays her eggs, to the number of two hundred and fifty or three hundred, in a boat-shaped mass, on the surface of any natural or artificial receptacle for fresh water. Early in spring the larvæ are found in the bottoms of pools and ditches, feeding upon decaying matter (hence the works on entomology state that they are of great benefit in *clearing swamps of miasms* (?)). These larvæ are the so-called "wrigglers," or "wigglers," to be found in great numbers in any stagnant pools of water during summer. They change into pupæ, and, in a few days more, the pupa-skin is cast, and floating on this latter, like a raft, the insect finally takes flight, a full-developed gnat. Many thousands perish by drowning, or are devoured by fish while extricating themselves from their pupa-cases. As the eggs develop into perfect insects in three or four weeks, many broods are hatched during the warm season, which accounts for their increasing numbers during the later summer and autumnal months. Some species deposit their eggs in soft mud or in dry sand, but all require moisture in the larval state.

2. "Malaria is hardly ever developed at a lower temperature than 60° Fahr." A temperature of 60° F. is necessary for the development of the mosquito.

3. "The evolution or active agency of malaria is checked by a temperature of 32° F." The mosquito is killed or paralyzed, so that *its* active agency is checked, by a temperature of 32°.

4. Malaria "is most abundant and most virulent as we approach the equator and the sea-coast." The swarms of mosquitoes (as well as of sand-flies, ants, and other insect-plagues) that infest many equatorial regions are well known; and, with regard to sea-coasts, the accumulation of mosquitoes is both a fact and easily susceptible of explanation. Under the influence of gentle land-breezes the mosquito is wafted toward the ocean, but, in the absence of strong winds that

* Most of them are quoted from a paper read by Dr. John T. Metcalfe, United States Sanitary Commission, 1862; see, also, Flint's "Practice," p. 826, edition of 1867.

would carry it out to sea, the water will form a barrier to its farther progress seaward, for it is not a marine insect. Mosquitoes, therefore, accumulate on sea-coasts—notably at some of our familiar summer resorts, Cape May, Atlantic City, etc.

5. Malaria "has an affinity for dense foliage, which has the power of accumulating it when lying in the course of winds blowing from malarious localities."

6. "Forests or even woods have the power of obstructing or preventing its transmission under these circumstances."

These last two propositions, embodying, first, the "accumulation," and, second, the "obstruction," of malaria by forests and trees, may be considered together. That a wind coming from a marsh (from, in fact, a mosquito nursery), and bearing a colony of mosquitoes, should be screened or sifted of its insect burden by passing through the foliage of a forest, or a belt of trees, is certainly far more comprehensible than the conception of a malarial vapor being so screened by virtue of its "affinity for foliage." And though, in the case of a single belt of trees, even the mosquital filter may *appear* imperfect, the insect, should it have been carried far, is probably anxious to settle, and may so vary its course by steering as to take the first opportunity of clinging to anything that may come in its way; and, having settled, we may readily conceive its shifting round to the leeward side of a leaf or branch, and there holding on until the wind sufficiently subsides to allow of safer flight. Thus mosquitoes, like malaria, may both accumulate in, and be obstructed by, forests and trees.

The conduct, or rather the mechanical properties, of the mosquito, when carried by the wind, can hardly be better described than in the following verbatim quotation from Sir Francis Day, in his description of malaria. He says: "Malaria may be carried by the winds to places where it was not generated; it is obstructed by and hangs in the foliage of trees, or in mosquito-curtains; it subsides into low places, and may be blown over a hill, and, may be very virulent on the side opposite to that on which it was formed. In like manner it may be taken up the side of a hill, and, as a lull takes place in the atmosphere, consequent upon its weight it rolls down, and may thus envelop its base with a deadly belt of fever, for there, hanging in the leaves of the trees, it gradually sinks through them to the earth beneath, in which situations it is most dangerous to pass the night" (Sir Francis Day's work, p. 87).

7. "By atmospheric currents it" (malaria) "is capable of being transported to considerable distances, probably as far as five miles." So, certainly, is the mosquito.

8. "It" (malaria) "may be developed in previously healthy places by turning up of the soil, as in making excavations for the foundations of houses, tracks for railroads, and beds for canals." Here two things are confounded, viz.: 1. Turning up of the soil, as by plowing or dig-

ging; and, 2. Making excavations. Which of these two is the more fruitful in producing malaria is not stated, nor is the *modus operandi* of either suggested. In Hong-Kong, an island consisting of little more than bare and barren rocks of weather-beaten granite, and whose soil contains but two per cent of organic matter, malarial disease was formerly unknown, and only became prevalent, as it is at present, after *excavations* had been made in digging granite for building purposes. So, again, tanks and pools of water—cess-pools, mill-ponds, reservoirs, and bilge-water on shipboard—appear to be specially productive of malaria. In Ceylon, the tanks of Candelay and Minery—the one twenty miles in circumference, the other twelve—have been considered the cause of malaria in that region (see Davy on "Diseases of the Army," p. 51, etc.). It is easy to comprehend how such pools, tanks, and excavations containing water may constitute mosquito-nurseries, where the female may deposit her eggs and propagate, which would probably have been prevented in the absence of such water accumulations. How simply digging up the soil may contribute to the formation of malaria, or to the development of mosquitoes, *without excavations*, I am not able to explain.

9. "In certain countries it" (malaria) "seems to be attracted and absorbed by bodies of water lying in the course of such winds as waft it from the miasmatic source." That the malaria itself is absorbed by water is pure hypothesis. The known fact embodied in this ninth statement is really this: A body of water intervening between a healthy locality and a fever district will, provided it be sufficiently wide (three fourths of a mile or more) prevent the transmission of fever from the infected to the healthy locality, also provided, of course, that the prevailing wind does not blow the fever-generating element from one side to the other, as we have already seen it may do over a much wider space—probably five miles. This, again, is not difficult of possible explanation by the mosquito theory. All depends upon the answer to this question: Over how wide a sheet of water will the mosquito, in the absence of irresistible winds, attempt to fly? I am unable to answer this question positively. It may depend upon the degree to which the insect possesses far-sightedness, for, if it can not see land across a body of water three fourths of a mile wide, such a width would appear to its vision boundless as an ocean, and under those circumstances it might not voluntarily attempt to cross. Furthermore, the flight of the insect being mostly nocturnal, long vision would be all the more difficult. These suggestions need confirmation: they are tentative, but still sufficient to suggest the possibility of the protective influence of wide bodies of water being explicable on the mosquital basis.

10. "In proportion as countries, previously malarious, are cleared up and thickly settled, periodical fevers disappear." Here, too, we may remark that in such countries the land is cultivated, and its

swamps and pools drained, so that the mosquito can not so readily find a place suitable to deposit her eggs. And, as the forests and underbrush disappear before the implements of the agriculturist, colonies of mosquitoes, wafted from a distance by winds, are not "obstructed" and "accumulated" by foliage, nor can the insect so readily escape, as before, the numerous fly-catching birds that feed upon it. Even here, however, artificial pools, tanks, and excavations containing water, may constitute mosquito-nurseries from which many millions may be developed in a single summer.

11. Malaria usually keeps near the surface of the earth; it is said to "hug the ground" or "love the ground." When blown by the wind, however, or drifting up ravines, it has been known to rise several thousand feet. Dr. Russell, in his address before the New York Public Health Association, April 13, 1876, stated that, "under ordinary circumstances, a certain altitude affords immunity from malaria, although low elevations of 200 or 300 feet above a miasmatic tract are often more dangerous than the flat lands, the poison seeming to float upward and become intensified." This, he says, has long been noticeable on the heights of Bergen Hill, West Hoboken, and Weehawken, which overlook the Jersey flats. In accordance with the malarial vapor theory, these facts are completely mysterious. The mosquito, on the other hand, is known to hover near the ground (or water) from which it springs, and, being wafted by winds, can readily be understood to be "obstructed" and "accumulated" by forests on the brows of hills, etc.

12. Malaria is most dangerous when the sun is down, and it seems almost inert during the day. Of this there is no doubt, and the various hypotheses on the marsh-vapor theory, that have been alleged in explanation of it, are almost as numerous as they are unsatisfactory. With regard to the mosquito, however, it is well known that it remains, for the most part, during the day, harbored in woods, weeds, or low underbrush, and comes out after sunset and at night to indulge its blood-sucking proclivities.

13. The danger of exposure after sunset is greatly increased by the person exposed sleeping in the night air. Again have the hypotheses based on the marsh-vapor theory been altogether insusceptible of explaining this circumstance satisfactorily. With regard to mosquital inoculation, however, it is undoubtedly true that, while awake, the person exposed will move about, or brush away the insect, while he will submit to be bitten during sleep.

14. In malarial districts, the use of fire, both in-doors, and to those who sleep out, affords a comparative security against malarial disease. Explanations on the marsh-vapor theory are numerous, various, and unsatisfactory. With regard to the mosquito, however, it is well known to be attracted by lamps, lights, and fires, into which it heedlessly flies at the cost of life. In countries where these insects are extremely nu-

merous, lamps are extinguished by the accumulation of their dead bodies. Every fire, therefore, whether in-doors or out, is a sort of mosquito hades. In some tropical countries, despite heat of climate, fires are kept up all night in every apartment as a preventive against fevers; and experience has demonstrated that they are more effective when placed between the open window (or door) and the body of the person to be protected. In this way it is easy to comprehend how every mosquito will fly directly into the light and the fire before reaching the thus protected sleeper.

15. "The air of cities in some way renders the poison innocuous, for, though a malarial disease may be raging outside, it does not penetrate far into the interior."

In conformity with this statement, we may easily conceive that mosquitoes, while invading cities during their nocturnal pilgrimages, will be so far arrested by walls and houses, as well as attracted by the lights in the windows and streets of the suburbs, as that many of them will in this way be prevented from penetrating far "into their interior." Even a single row of houses, on one side of a road, with its contiguous fences, lamps, and closely-knit hedge-rows, may so far completely obstruct the onward flight of mosquitoes coming from some neighboring swamp as to prevent their crossing the street. The curious instances in which people living on one side of a road are attacked with ague, while those living on the other side escape, as on the high-road between Chatham and Feversham (see Macculloch on "Malaria," p. 121), and in Cività Vecchia (see Johnson on "Tropical Climates," p. 315), are quite as susceptible of possible explanation by the mosquito theory as by the marsh-vapor conception, for that the infected air from the marshes does not cross the street is inconceivable.

16. "Malarial diseases are most prevalent toward the latter part of summer and in the autumn."

It has been already explained in what manner—and the fact is a common observation—mosquitoes are more numerous also during the later summer and autumn months.

17. Malaria is arrested, not only by trees, walls, etc., but also by canvas curtains, gauze veils, and mosquito-nets.

Sir Francis Day (p. 87) tells us that travelers, besides being warned against night and morning temperature, should be instructed at night to employ mosquito-curtains "through which malaria can seldom or never pass."

Dr. Macculloch (pp. 137, 138) says that, by surrounding the head with a gauze veil or *conopeum*, the action of malaria is prevented, and that thus it is possible even to sleep in the most pernicious parts of Italy without hazard of fever. The prophylactic efficacy of fine cloth or gauze at night is further attested by Dr. Johnson ("Tropical Climates," pp. 316, 317), as quoted on p. 318 of La Roche's well-known

work. (See also p. 416 of Dr. Johnson's work, and p. 15 of Dr. W. J. Evans on "Endemic Fevers of West Indies," 1837.)

Dr. Oldham ("What is Malaria?" p. 172) tells us that the Jeevas of the Punjaub, employed in fishing and catching wild-fowl, spend the whole night in their boats, under the reeds of the marshes, "unharmed in the midst of malaria"; but they are wrapped from "head to foot" in a peculiar costume that completely envelops them, and which they always put on at sunset; and, moreover, a smoldering fire is kept up in the boat.

It is almost needless to add that, while these nets, curtains, etc., can hardly be conceived to intercept marsh-air, they certainly can and do intercept and protect from mosquitoes.

18. Malaria spares no age, but it affects infants much less frequently than adults.

The child *in utero* has even been alleged to suffer from ague when its mother was affected: she has felt it, as she supposed, shivering or executing spasmodic movements during the paroxysm, and such infants have been born with enlarged spleens. Nevertheless, it is a matter of daily observation that the sucking infant is less liable to malarial disease than older children and adults.

Young infants, however, be it remembered, are usually carefully housed, and in summer their beds or cradles are generally provided with mosquito-curtains to keep off house-flies, and they may thus be protected from mosquital inoculation. Furthermore, since the human infant, in savage life, and without the artificial protection of gnat-curtains, would be presumably helplessly exposed to mosquito-bites, it would not surprise us if Nature had given the infant some inbred eccentricity by which the inoculations would be rendered harmless; just as the bite of the African *tsetse*-fly, which will destroy cows and oxen, is perfectly harmless when inflicted upon the sucking calf, as attested by Burton, Livingstone, and Stanley.

19. "Of all human races the white is most susceptible to marsh-fevers, the black least so."

The black man, however, is not entirely exempt, and is probably more secure in his native clime than in the United States and other civilized countries to which he has been imported. Acclimatization is alleged to be the proper explanation of this exemption. The negro, it is said, is born in a country where he is obliged almost incessantly and universally to breathe malarial emanations; he is descended from ancestors who, from prehistoric times, have lived in such poisoned air; he has thus become acclimatized to it more than any other race, and on this account is able to prosper in places where the white man would suffer for a long time (see Quatrefages's "Human Species," p. 223, Appletons' "International Scientific Series"). But we are not told in what this acclimatization consists. Will the mosquito theory furnish any probable explanation?

Crude, simple, and at first sight ludicrous as it may appear, it is nevertheless worthy of consideration that the negro is *black*, and, in the absence of moonlight or artificial illumination, can not at night be so readily *seen* as a white man; he may therefore on this account escape the sight, and consequently the bite, of the mosquito. The deep tint of his skin possibly constitutes a "*protective coloring*," such as in many other species affords a defense against natural enemies. Moreover, the habit, common with many negro races in their native heath, of daily anointing the body with grease, affords additional protection against mosquitoes, as do also, probably, the offensive odor and greasiness of his cutaneous secretions. In this connection the work of Dr. Balfour on "Sol-Lunar Influence" in malarial fevers, hitherto ignored, deserves reconsideration. The light of a full moon would render the negro more visible to his culicidal enemy.

When the negro is imported into this country, and subjected to the conditions of civilized life—which usually comprise, among the rest, his remaining during a part of the evening in rooms artificially illuminated, or sleeping with his black body portrayed in bold relief upon white bedclothing—the mosquital blood-suckers will then have little difficulty in finding their victim, notwithstanding his protective melanotic mantle.

THE CONSERVATIVE FUNCTION OF AGUE.—In my original paper, read before the Philosophical Society of Washington, on the 10th of February last (and of which, as I have said, the present production is an abstract), I suggested that the natural conservative design of the processes embodied in the term ague was to develop *malarial melanosis*—in fact, to change the skin from white to black, thus securing adaptation to (i. e., protection against) the environment of inoculating gnats, by clothing the individual with a cutaneous mantle of "protective coloring." The spleen I therefore regarded as the organ, one of whose offices is, as it were, to preside over and determine the cutaneous coloring of the individual—a function not hitherto ascribed to it; though its pigment-forming function, by destruction of blood-corpuscles in its substance, has been long known. The absolute transformation from white to black under the influence of malarial disease has been frequently observed (see a case by Dr. William H. Falls, in the "Cincinnati Lancet and Observer," November 18, 1882, pp. 479–488). Surgeon-General C. A. Gordon, in his account of the fever among the British troops in Cyprus ("London Medical Press and Circular," new series, vol. xxx, p. 303), in 1878, says: "The Forty-second Regiment suffered terribly at Cyprus; the men looked worse than they did on the Gold Coast—pale and sallow, or *black* (italics *his*), the pure malarial melanosis."

Be it noted, further, that the causes or conditions that lead to different tints of color in different races of men—since it is now known not to depend, as once supposed, upon heat of climate—is a complete

and inexplicable mystery; a mystery, however, that may be now possibly explained by man's geographical relations with his zoölogical tormentors, the proboscidean *diptera*.

That malarial diseases occur frequently without the development of malarial melanosis is not difficult of explanation. The disease is not permitted to pursue its natural course; it is interrupted by quinine. The individual, moreover, is clothed, or protected from the sun —an artificial appendage and addition to the organism which the ancestrally inherited powers of adaptation could scarcely anticipate would occur. Possibly, if every ague-patient were exposed to a broiling sun, naked, during the chill, and were then suffered to follow the bent of his successive inclinations during the remaining stages of the disease, the accumulated pigment enlarging the spleen would find its natural and more salutary destination in an even distribution over the cutaneous surface—a phase in the natural career of the disease which seems to be further indicated by the circumstances that the chills of ague only occur, in typical cases, between sunrise and sunset, the paroxysms getting of later and later occurrence, as they are wont to do, until reaching sunset, when the night is "skipped," and the attacks begin early next morning. It seems as if Nature required the sun during the chill, in order that her beneficent purpose of protective cutaneous pigmentation should be carried out.

Although the ethnological bearings of this subject hardly belong to a medical paper, I can not refrain from expressing the suggestion that it is not at all impossible that future study and observation may demonstrate that much of the difference in type between the lowest grade of negro and the most perfect Caucasian white may find its true explanation in the changes produced by an environment of inoculating gnats. Even the characteristic type of the negro skeleton and the capacity of his brain, it is not impossible, may be susceptible of explanation in this manner; for, when we remember that the spleen and its allies are not the only pigment-forming organs, this function being also performed by the marrow of bones, and when we recall, further, the aching of bones that so often attends an ague-chill, in some cases so severe as to have originated the term "break-bone fever," it is not difficult to conceive that the bone-marrow, like the spleen, may become congested during the chill, and in this way, in the course of time, so far lead to modified nutrition of the osseous structures as to set up, finally, a change of type in the embryological formation of the skeleton.

In certain tropical regions it has already been observed by ethnologists that tribes inhabiting elevated regions in the interior are superior to those dwelling on low tracts on the sea-coast, the superiority being manifest both in mental and bodily qualities. The lowlands and sea-coasts, however, are favorite habitats of the fever-producing and pigment-producing mosquito.

In further support of the mosquital origin of malarial disease, we may remark the general admission on the part of medical authorities that sickly seasons and localities are usually accompanied with an extraordinary number of winged insects, many of them being blood-sucking diptera. Lind, in his "Essay on the Health of Semen" (p. 58), referring to an army of Christians, half of whom were lost by fever while passing through Hungary, tells us, "The air swarmed with insects—a sure sign of its malignancy" (p. 60); and, in referring to the climate of Guinea and of the East and West Indies as being fatal to Europeans, he adds, "More especially when molested with heat within-doors, and the plague of mosquitoes, they have ventured to sleep in the open night-air" (p. 71). And again, describing a journey from the interior of Guinea to Senegal, he says (p. 94): "The earth had its white ants, the air its wild bees, its sand-flies, and its mosquitoes. These insects, though not the most tremendous, were perhaps their (the travelers') most distressing enemies." On page 77 he remarks: "The greatest plague was the mosquitoes and sand-flies, whose incessant buzzing and painful stings were more insupportable than any symptom of the fever." After landing on the Canaries the health of the men immediately improved, but they were here no longer "tortured with swarms of blood-sucking gnats and flies" (pp. 83, 85).

Mosquitoes are not generally troublesome in England, yet in the ague-fens of Lincolnshire and the swamps of Essex the use of mosquito-nets is as necessary and common as in India or any other tropical climate ("Chambers's Cyclopædia," article "Gnat"). The prevalence of the mosquito-plague in the fever-districts of Italy is also well known.

Furthermore, in certain districts where the so-called "malarial poison" is supposed to be lodged in trees and bushy plants near the ground, it has been observed that those persons are particularly prone to fever who cut down or disturb these malaria-laden plants, which is extremely suggestive of the mosquitoes being disturbed from their reposing haunts, just as one might get stung by stirring up a bee-tree or a hornet's nest. La Roche, in his well-known work (p. 282), says: "Malaria is collected by plants, particularly those of a dense and entangling foliage, so as to be disengaged on cutting them down or rooting them up, thus exciting fever in the laborers who might otherwise have escaped, as proved by the circumstance that in all these situations, while the workmen are in the erect posture and engaged at their work, they escape the fever, but are attacked if they sit, and more particularly if they lie down on the ground—and that whether they sleep or not."

Here it may be observed that the circumstances stated to conduce to the production of fever (viz., sitting or lying still) are exactly those which would favor being bitten by mosquitoes, the insect having less chance of inflicting its inoculating wound while the men when in motion are "engaged at their work."

The same thing has been observed by Macculloch in the Roman Campagna, where, he says (p. 124), it is remarked that, "if the laborers cut down certain plants (a bushy thistle chiefly), a fever, that would otherwise not have occurred, is the consequence."

In opposition to the mosquital origin of malarial disease it is known that numerous mosquito wounds may be inflicted without the occurrence of malarial disease; but this is by no means incompatible with the theory. We do not yet know whether the poison be mosquital saliva, or whether the fever-producing element be a bacillus with which the puncturing proboscis of the insect may be loaded at the time of inflicting its wounds. The scratch of a lancet will not produce vaccinia, unless the instrument be charged with vaccine matter; the puncture-needles of Pasteur would be harmless and impotent, did he not load them with infecting bacteria; so with dog-bites and hydrophobia, etc.

Nay, it may even turn out that, under certain circumstances, mosquito-bites shall even be protective against malarial disease, for as Pasteur and others are able to produce, artificially, "attenuated culture-fluids," the inoculation of which, while producing slight symptoms, protects from more serious phases of disease, so may there exist in nature naturally "attenuated" fever-poison fluids, the inoculation of which, by mosquital puncture, may produce trivial symptoms, and thus protect from more decided attacks of veritable fever. What product of man's art has not been anticipated by Nature? Hardly any.

In the absence of direct experiments with the mosquito as a fever-producing agent, I have endeavored to ascertain if the geographical distribution of the insect had any relation with that of malarial disease. But the insect and the disease are both so wide-spread that it is difficult to find any locality entirely exempt from either. Tasmania, Singapore, New Zealand, Ceylon, and the Dismal Swamp of North Carolina, as well as the bog-country of Ireland, are said by some medical writers to be entirely exempt from fevers. Others discredit this statement. I do not know who is right; but I have endeavored to ascertain whether insects of the mosquito tribe were or were not rife in these localities. On this point there seems to be little scientific knowledge available. Of the insects of Singapore—a locality in which the absence of fever seems to be generally admitted—I have been able to find no account. With relation to Tasmania (Van Diemen's Land), where exemption from fever is again generally admitted, I have only been able to find, in the Capitol Library, one reference to its insects. This is from the work of James Bischoff (London, 1832, p. 33), who, quoting from Widowson's "Present State of Van Diemen's Land," says: "The insects are not so numerous or so annoying as in most other tropical countries. The ant, the mosquito, and a common green fly are chiefly seen. The mosquito does not sting so severely as in hotter climates."

With regard to Tasmania, it may also be observed that the native inhabitants are universally of one color—absolutely black—which would suggest a previous history of malarial disease to which a prolonged succession of generations has finally secured complete adaptation and consequent exemption from symptoms. How far the eucalyptus-tree, which here abounds, has been instrumental in correcting malarial disease, also deserves consideration. Possibly the sticky, pendent leaves, and camphoraceous odor of the plant are not conducive to the prosperity of the mosquito genus.

The Dismal Swamp, so far from being exempt from mosquitoes, is said to abound with them during the autumn. Alexander Hunter, writing in "Potter's American Monthly," July, 1881, page 15, says: "The mosquitoes were in uncounted millions; they came armies on armies, waves upon waves, clouds upon clouds, and charged in platoons and single file, and threw themselves with bloodthirsty voracity upon every living thing in reach." On the same page, however, his negro guide, "Bob," is made to say that he reckons he would be quite fat "but for the 'skeeters and chills." Another writer ("Harper's Magazine," vol. xiii, 1856, page 450) refers to an hotel having been erected for a summer resort in the "Dismals," but "before the month of August visitors, servants, and proprietors had all cleared out and left the place in full possession of the mosquitoes and yellow flies. These insects are said to be savage enough to worry the life out of a mule. . . . The hotel was taken down."

In so far, therefore, as regards the geographical relation between mosquitoes and malarial disease, it may be said: 1. The two often coexist; 2. There is no decided proof that localities alleged to be exempt from ague are also exempt from mosquitoes; 3. There is no locality noted for malarial disease where mosquitoes or other blood-sucking insects do not exist.

In those isolated cases of ague occurring during the winter or early spring, before inoculating insects have made their appearance, there may of course be other modes of inoculation. We have only to admit the production of the *bacillus malariæ*, its transmission in the air and its deposit upon the skin, to see how easily it may be inoculated into the body by accidental wounds, such as pin-scratches, the cut from a pocket-knife, or of a razor in shaving, etc. Furthermore, it is generally admitted by medical authorities that the period of inoculation after the poison is introduced into the system may, exceptionally, extend weeks and even months before symptoms are developed. In these, or in some other ways, the isolated winter cases referred to may therefore be explained without necessarily conflicting with the mosquito theory. Finally, it seems incredible that a function so necessary to life as respiration—a function that can not be suspended in any atmosphere—should be the means of infecting the body with a fatal disease. It was surely never designed that breath-

ing the indigenous air of any natural environment should be, and without warning of danger, a means of death. Such a supposition is inconsistent with that general beneficence of Nature as exhibited in the signals of danger, instinctively recognized by all living things, when contemplating their natural enemies, and when in the presence of conditions that are destructive to life.

Man naturally loves beautiful things—woman and the flowers. But the serpent also is beautiful—superficially smooth, tapering in form, elegantly elastic, absolute in symmetry, undulating in motion, every element of beauty in woman finds its counterpart in the snake; yet we love the one, loathe the other—loathe it because we have inherited the instinct that tells us it is one of our natural enemies, whose touch is destruction; and, when sight is not sufficient, the rattle is added, so that even in darkness we may hear the warning note of danger.

When man is prompted by Nature to invade a swamp in pursuit of fowl and fish, his natural foods, it can not be that the silent air he breathes shall, like a subtle enemy, and without any admonition, destroy his life. But when night comes, should he there lie down to rest, the annoying puncture of the mosquito and its siren-song, like the warning note of the serpent's rattle, would emphatically and persistently tell him, "This is no place to sleep!"

The mosquital origin of malarial disease is in this respect, therefore, more in accord with the beneficence of Nature's arrangements than is the conception of malarial fevers being produced by the respiration of a marsh-vapor.

I have before referred to "color-protection" as a means of defense from natural enemies. *Acuteness of audition* is another well-known means. It curiously happens that some forms of fever are followed in those who convalesce by a remarkable acuteness of hearing, which lasts for weeks and months, thus indicating another phase of adaptation to environment, an additional means of recognizing the warning note of the inoculating mosquito, or other insects inaudible to ordinary ears. Dr. J. B. Allan refers to this symptom in his description of a remittent fever prevailing on the African sea-coast ("Monthly Journal of the Medical Sciences," August, 1841, page 545). He says: "The acuteness of hearing sometimes came on during the second day in those who recovered. It was very distressing for the first six weeks or two months of convalescence; and every wave that burst on the distant reef was counted with pain and even dread."

If the mosquital origin of malarial fevers be correct—if protection from mosquital inoculation protects from ague—the means of prophylaxis from malarial disease will not be difficult. It comprises the following items:

1. *Personal* protection from all winged insects, especially during evening and night, by gauze curtains, window-screens, or clothing im-

penetrable to their probosces—a further protection from these, as well as from the bites of creeping insects, especially during epidemics and endemics in jails, ships, etc., by a daily inunction of the whole body with some terebinthinate, camphorated, or eucalyptalized ointment or liniment.

2. *Domiciliary* protection, exteriorly, by screens of trees, walls, fences, etc., interposed at some distance between dwellings and the sources of malaria or mosquito nurseries, together with fires, lamps, or electric lights, to act as traps for the attraction and destruction of such winged insects as may approach nearer; a further protection in the interior of dwellings being secured by the use of smoke (such as that of tobacco or pyrethrum), or of some volatile aromatic oil, as of camphor, etc., which may be offensive to proboscidian intruders.

3. *Municipal* protection, by the destruction or draining of swamps and pools which produce mosquitoes; and by the planting of forests to obstruct the latter in their flight, or cordons of electric lights for the same purpose, as well as for the destruction of insects that may be attracted by the flame or incandescence.

THE GROWTH OF HYGIENIC SCIENCE.*

By Professor DE CHAUMONT, M. D., F. R. S.

IT is a little difficult in a necessarily restricted lecture to convey any exact idea of the way in which modern hygiene became formulated into so much of a science as it can at present lay claim to; but I will attempt to make a brief sketch of its more salient points. In the eighteenth century there were several important questions inquired into, and to a large extent solved, of which the chief were—1. The influence of air as a factor in the spread of disease; 2. The true cause and prevention of scurvy; and, 3. The prophylaxis of small-pox. Taking the last first, we may say that the introduction of inoculation was a most important step, even although we must admit that it introduced a greater danger to the community at large than could be compensated for by the protection to individuals. But it was the first step on the road which led at the close of the century to vaccination, one of the most signal triumphs of preventive medicine, and in our own time to the magnificent results obtained by the renowned Pasteur, results which seem pregnant with so much hope for the future of our race.

The inquiry into the causes of scurvy was another step in advance, of the most signal importance. No one in the present day can form

* From the inaugural lecture of the Parkes Museum, delivered June 1, 1883.

any idea of the ravages that terrible disease produced. All long voyages were imperiled by it, while the very existence of England depended upon her fleet, which had frequently to return to port absolutely crippled with scurvy, in some cases as many as ten thousand men being landed from the Channel fleet helpless. Although so far back as the seventeenth century the efficacy of fruits and fresh vegetables as preventives had been surmised if not actually noted, it is really to the renowned Captain Cook that the credit is mainly due of having established this important fact. That eminent navigator never lost an opportunity of taking on board fruits and fresh vegetables whenever he could, and the result was that he was able to bring home from a lengthened voyage crews in almost perfect health and condition, a thing never before known. It took many years, however, to impress this fact sufficiently upon the authorities, and it was not until 1796 that the medical officers of the navy (among whom was the renowned Sir Gilbert Blane) obtained the regulation ordering lime-juice to be supplied to our seamen. The effect was magical: scurvy lost its terrors, and it may be that the supremacy of England at sea during the Napoleonic wars was in part owing to the improved condition of her seamen during that gigantic struggle. We have still a monument of the extent of the disease in the immense naval hospital of Haslar, the largest in this country, which was built of such dimensions mainly to admit the extraordinary number of scurvy patients which were being continually landed from our fleets. We have not yet got entirely rid of this enemy, but I think we know now how to combat it, in spite of heretical opinions which find expression from time to time.

The recognition of foul air as a factor in disease was certainly begun in the last century, when the brilliant discoveries in pneumatic chemistry made by Lavoisier, Cavendish, Priestley, Black, and Rutherford threw such a flood of light upon a previously obscure subject, and opened the whole immense vista of the boundless science of modern chemistry. It was only then that the physiology of respiration could be even partially understood, and the changes recognized which take place in the respired air from the lungs of man. The great disaster of the "black hole" of Calcutta, and the terrible effects of the jail-fever, investigated by Howard and others, pointed to foul air as a main factor in the propagation of disease and death; and this was further corroborated by the observations made by military surgeons that outbreaks of typhus (or putrid fever) were most rapidly arrested when troops were encamped and scattered widely over the surface of the ground. It was reserved for the later researches of Neil Arnott and other hygienic observers of the present century to prove the still more important fact that foul air is the main cause of the still more general and fatal class of destructive lung-diseases, which in this and in other lands cut off so many of the brightest and the best.

Another important discovery of the last century was the determination of the cause of the well-known lead-colic by Sir George Baker. This opened up the large field of metallic poisoning which has received so much elucidation and proved of such importance in reference to the water-supply of large communities.

In the present century we have to point to the establishment of the fact of the water-carriage of disease, with which the name of Snow is so honorably associated, the differentiation of continued fevers by Stewart and Jenner, and their connection with the poison of infected excreta by the labors of Budd and other eminent men. To those we must add the elaborate investigations into the modes of propagation of cholera, dysentery, and other tropical diseases, and the means by which scarlet fever, diphtheria, etc., are carried from place to place by various channels of communication. It would be unadvisable, even if it were possible, to enter into details on these points, but there is one branch of the subject on which we must dwell for a little. No inquiry can assume a scientific form unless it has a numerical basis to work upon, and therefore it behooves us to note the starting-point of such a basis in hygiene, if we can find it. This we do find in the collection of statistics, a beginning of which was made a long time ago in the bills of mortality kept in this country. We know how imperfect those were, and how even the population of this country was not correctly known until within the lifetime of men still living. But still beginnings were made, and the question taken up more and more enthusiastically by enlightened men, until at last the Government Statistical Department was formed, and that remarkable series of reports begun which will immortalize the name of William Farr. From that time the future of hygiene was assured; for there was sound ground to work on, and, if we add to that the valuable reports on the health of towns published by the commission of which the present Duke of Buccleuch was president, we shall have stated some of the most important foundations of modern sanitary science. Those reports disclosed a state of things little dreamed of, and the statistical returns compiled by Dr. Farr showed how much the life and health of the nation were dependent upon the conditions in which its individual members were placed. The establishment of the General Board of Health, under Mr. Chadwick, was one of the valuable outcomes of this remarkable movement. Although the original Board of Health was brought to an end in 1854, yet its work has been continued and expanded under Mr. Simon, his colleagues and successors, in spite of many difficulties and obstacles.

The part which the public services, such as the army and navy, played in the progress of hygiene was very important, as might indeed be expected; for under no other circumstances could bodies of men be so well observed, and the effects of surroundings and conditions upon health noted. Accordingly, we have a long roll of names

connected with those services which must ever be remembered with honor: in the navy we have such men as Lind, Blane, Trotter, Burnett, etc.; and in the army, Pringle, one of the most philosophical physicians who ever lived; Brocklesby, Fergusson, McGrigor, and a host of others. The labors of the late Sir Alexander Tulloch, Deputy-Inspector-General Marshall, and Assistant-Surgeon (now Surgeon-General) Balfour, in collecting and arranging the army statistics, were of the highest value, and it is not too much to say that the publication of the first army medical statistical report marked an epoch in hygiene, especially in that part that deals with climatology. It exposed the fallacy of the common notions of acclimatization, of the advantages of a seasoning fever, and similar ideas. It showed also that it was possible for men of temperate habits and in hygienic conditions to live and thrive in the tropics, while the death and sickness that were unfortunately so common were due much more to the ignorance and folly of man than the influence of climate in any form. The truth of that is to be seen now when life in the West Indies is actually healthier, especially for young soldiers, than service at home, whereas sixty years ago a tour of service there was looked upon as almost a sentence of death. It is true we have still yellow fever to combat, but we know now much better how to deal with it when it does come, and how to obviate its invasion when it is threatened. The army medical statistics are continued now yearly, but it is a matter of regret that they have been allowed to be published in so abstract and undetailed a shape as to deprive them of much of their utility. It is to be hoped that this mistake may be remedied, and that the saving of a trifling sum, which is said to be the reason, may be recognized as a truly false economy. But perhaps the most remarkable contribution the army has made to sanitation has been by the evidence given to the Royal Commission of 1857, which met after the Crimean War to investigate the causes of the sickness and mortality of our troops. The results of that commission are well known, and from its publication may be dated the reforms which have been productive of much advantage both to our own and foreign armies, and to the civil population as well. The paramount influence of foul air in the production of lung-disease was proved to demonstration, and the art of ventilation was placed upon a secure foundation. The Barrack Hospital Committee, of which Dr. Sutherland and Captain Douglas Galton were the active members, laid down a series of regulations for the construction of barracks and hospitals, which have been followed with the utmost benefit both at home and abroad. Following this came the Indian Commission, which did for that vast dependency what the Home Commission had done for the rest of the empire. The mortality in India was found to be inordinate, and it was equally clearly traced to insanitary habits and surroundings. To recognize an evil and its cause is half-way to curing it, and after a

lapse of a quarter of a century we can point, not certainly to perfection, but to such an improvement as might fairly at one time have been looked upon as chimerical. The death-rate of the army at home is only two fifths of what it was before the Crimean War; the death-rate in India is only one third; and the death-rate in the West Indies one tenth.

In civil life it has recently been shown that the improvements of later times have resulted in a diminution of two per thousand in the general death-rate, and with the knowledge we now have of the causes of disease we may be sure that a general death-rate of not more than fifteen per thousand may be confidently looked for. We have not yet got rid of the fatal endemics in our midst, but they are in some directions diminishing, and we have good hope for the future; while it seems probable that neither cholera nor any other introduced pestilence could establish a foothold in our land. The remarkable immunity of soldiers and prisoners in the last epidemic shows what can be done when people can be compelled to lead fairly hygienic lives.

I might extend this lecture by reference to the various theories of disease propagation, but time will not permit of it, even if it were otherwise desirable. I may, however, say that no one theory yet promulgated completely satisfies the requirements of the case, and that there may be some basis of truth even in the most conflicting views. So much has been done hitherto, and so much activity is being shown in investigation, that we can not fail ere long to find the key to many of the mysteries that now baffle and perplex us. It is quite clear that it is only by a knowledge of the causes of disease that hygiene can be advanced, and that it can never be in any way perfected without a complete system of etiology; and we are at present in this position, that practical hygiene has to some extent outstripped the knowledge of disease causes. We look, therefore, anxiously toward the pathological investigations of the time, and we deeply deplore the well-meaning but misguided zeal which is at present placing such grave obstacles in the way of the only means by which true science can advance—namely, direct experiment.

Although there are many names I might refer to as great writers in hygiene, abroad as well as at home, there is one which we can not omit in a lecture like this, more especially as it is the first delivered in this museum which has been founded to his memory. Edmund Alexander Parkes did more than any other one man in this or any age to make hygiene a positive fact, a practical science, based upon not only philosophical conceptions but actual experiment. Starting in life as an army medical officer, he was able to produce, during his short service in India and Burmah, works upon dysentery and cholera which will always be of the greatest value. Retiring into civil life, he became eminent as a physician and teacher, and in 1855 he undertook the organization of the hospital at Renkioi, in the Dardanelles, which

was a perfect model of successful hygienic administration. Struggling with distressing and dangerous disease he continued to lead a life of intellectual activity not often accomplished by the most robust; and when, in 1860, the Army Medical School was established by Lord Herbert of Lea, Sir James Clark had no hesitation in advising that Dr. Parkes should be secured if possible as the Professor of Hygiene. How excellent the foresight of that eminent physician was, we all know, for Dr. Parkes was not only the first professor of the science in this country in point of time, but also the first in every sense of the word. The publication of his well-known "Manual of Practical Hygiene" gave us for the first time a work on the subject which was not merely a string of opinions and surmises, but at every point brought opinion to the test of figure and experiment, where it was possible, and thus laid the foundation for a real science in the future. Similarly with his teaching he pressed upon the Government to establish practical laboratories for his pupils, where they could do for themselves as much of the experimental work as time and opportunity allowed; and he impressed upon those who studied under him the necessity of testing everything by actual investigation and bringing all statements to the proof of figures before accepting them as true. There was never probably a man of calmer and more judicial mind, a man more rigidly critical of his own work, or more kindly disposed to allow every credit to the work of others. Having known him personally for many years, during thirteen of which I was his assistant and colleague, I can bear confident testimony to the exceeding beauty of his character, in which "sweetness and light" were never more truly displayed, and the scrupulous accuracy and care with which every investigation of his was carried out. The science of hygiene could have no purer and better founder and its votaries no brighter and more spotless example.—*Lancet.*

"OUR MARRIAGE AND DIVORCE LAWS."

By E. T. MERRICK.

AN article in the June number of "The Popular Science Monthly" for 1883, on the subject of "Our Marriage and Divorce Laws," it seems to me, is worthy of further notice.

We have no occasion to find fault with the picture which the writer draws of the divorce laws of many of the States. It is highly probable that the cause of the deplorable disregard of the binding force of the marriage tie, in certain of the Eastern States, must be sought for outside of the statute laws themselves. Laws or constitutions have but little value except public opinion demands their enforcement.

When the universal sentiment of a free people is opposed to a statute, it might as well not be written; it is practically a dead letter. It therefore seems to be of little avail to contend about the adoption of laws distasteful to the community in which they are to be enforced, and little use in passing them. The only true mode of obtaining beneficial legislation is to educate the people, who are to enforce the laws among themselves, to understand their necessity or usefulness. Most communities, when left free to act, understand their own wants and necessities better than anybody else.

Still, it does not seem so absurd for intelligent and benevolent people of New York and New England to disturb themselves about the laws affecting the marriage relation of negroes with white people in the South (say in North and South Carolina, Alabama, and Virginia), as it would seem for a colored congregation, or a meeting of field-hands in Louisiana, to pass resolutions condemning the divorce laws of Connecticut or Maine.

With the lawgiver, the contract of marriage—the most important of all contracts—may be supposed to rest upon the gravest considerations, and give rise to the most serious deliberations. He may well inquire:

1. What relations must be prohibited from marrying each other?

2. At how early an age may marriage be permitted, and what relations must be called upon to assent to the marriage of minors?

3. Ought the insane who have lucid intervals to be permitted to marry?

4. Are there any diseases—such as leprosy, elephantiasis, scrofula, or others—which ought to prevent the marriage of such diseased persons?

5. Ought marriage with inveterate drunkards to be prohibited?

6. Are there any crimes which ought to be considered as a bar to the marriage of the criminal?

7. Assuming, according to the prejudices of the largest number, that the white is the superior race, ought laws to be passed prohibiting marriage between white persons and Indians, negroes, Australians, or Chinese?

What will be the effect of such marriages on the welfare of the State? Will they drag down the assumed superior race, while they tend to build up the other race? Will such marriages offend the race prejudices alike of the black and white races? Or will such marriages be pleasing to the one race and displeasing to the other? Will not the violation of race prejudices by such marriages occasion unhappiness, and is there any advantage to the State to compensate the misery? What has been the result of the marriages of white women with negro men on the happiness of the wives and their offspring?

Such questions as these, it may be assumed, are in the mind and province of the Legislatures when marriage laws are framed, and who

shall say that such grounds ought not to be considered? When we bear in mind how difficult it is to pass laws through Congress, and how difficult it is to adopt uniform laws which do not operate harshly on some portion of our immense country, we may well question the advisability of amending the Constitution of the United States in order to put the subject of the marriage relation under the control of Congress. How many years has the Parliament of England been wrestling with the deceased-wife's-sister question!

So large a nation as ours, whether the laws are promulgated from Washington or the capitals of the several States, will always furnish the philanthropist with worry enough on a great variety of questions to make him comfortable, if not happy.

It is not probable that any laws which Congress could pass on the subject of marriage would be satisfactory to the advanced minority, and their passage would occasion the greater anxiety because such minority would suppose themselves in some manner directly responsible for the laws. It is, therefore, not at all strange that many of the State laws—such as those of Ohio, or Virginia, or Alabama, which prohibit marriage between the negro and white races—are supposed by people of other beliefs to contravene the fourteenth amendment of the Constitution of the United States. Hence, the writer of the article under consideration criticises the decisions of the Supreme Court of the United States for refusing to declare such laws null and void. He says the decision "abridges the privileges of a citizen on account of color; it denies the colored male citizen the equal privilege and protection of the law extended to the white male citizen—the right to marry a white woman. It denies the white female citizen the privilege and protection of the law granted the colored female citizen—the right to marry a colored man."

Perhaps the easiest way to set the matter right with those who might be inclined to think, from the adverse criticism, that the Supreme Court of the United States had erred, will be to state the facts of the case, and repeat what that high tribunal has said on the subject in the case of Tony Pace *vs.* Alabama, 106 United States Reports, pages 584, 585. Adultery and fornication, by section 4,184 of the Alabama code, are prohibited by a fine of one hundred dollars and imprisonment, with or without hard labor, *in the county jail*, for six months. Section 4,189 of the same code declares that, "if any white person and any negro, or the descendant of any negro to the third generation inclusive, though one ancestor of each generation was a white person, intermarry or live in adultery or fornication with each other, each of them must, on conviction, be *imprisoned in the penitentiary*, or sentenced *to hard labor* for the county for not less than two nor more than seven years."

The provisions of the fourteenth amendment to the Constitution of the United States prohibit any State from *making or enforcing*

any law "which shall abridge the privileges and immunities of citizens of the United States," or denying "to any person within its jurisdiction equal protection of the law." *This amendment required congressional legislation to carry it into effect.* It did not provide for its own execution. To give effect to the amendment, the famous Civil Rights Bill was passed in 1870, which is referred to in the opinion of the court.

In November, 1881, Tony Pace, a negro man, and Mary J. Cox, a white woman, were indicted under section 4,189 of the code of Alabama, and were convicted, and each sentenced to two years' imprisonment in the penitentiary. The State Supreme Court having affirmed the sentence, Pace sued out a writ of error to the Supreme Court of the United States. After full argument, through Mr. Justice Field, its organ, that court said: "The counsel of the plaintiff in error compares sections 4,184 and 4,189 of the code of Alabama, and assuming that the latter relates to the same offense as the former, and, prescribes a greater punishment for it, because one of the parties is a negro, or of negro descent, claims that a discrimination is made against the colored person in the punishment designated, which conflicts with the clause of the fourteenth amendment prohibiting a State from denying to any person within its jurisdiction the equal protection of the laws.

"The counsel is undoubtedly correct in his view of the purpose of the clause of the amendment in question, that it was to prevent hostile and discriminating State legislation against any person or class of persons.

"Equality of protection under the law implies not only accessibility by each one, whatever his race, on the same terms with others to the courts of the country for the security of his person and property, but that in the administration of criminal justice he shall not be subjected, for the same offense, to any greater or different punishment. Such was the view of Congress in the enactment of the Civil Rights Act of May 31, 1870, chap. 114, after the adoption of the amendment. That act, after providing that all persons within the jurisdiction of the United States shall have the same right, in every State and Territory, to make and enforce contracts, to sue, be parties, give evidence, and to the full and equal benefit of all laws and proceedings for the security of person and property as is enjoyed by white citizens, declares in section 16 that they "shall be subject to like punishment, pains, penalties, taxes, licenses, and exactions of every kind and none other, any law, statute, ordinance, regulation, or custom to the contrary notwithstanding.

"The defect in the argument of counsel consists in his assumption that any discrimination is made by the laws of Alabama in the punishment provided for the offense, for which the plaintiff in error was indicted when committed by a person of the African race and when committed by a white person.

"The two sections of the code are entirely consistent.

"The one prescribes, generally, a punishment for an offense committed between persons of different sexes; the other prescribes a punishment for an offense which can only be committed where the two sexes are of different races. There is in neither section any discrimination against either race. Section 4,184 equally includes the offense when the persons of the two sexes are both white and when they are both black. Section 4,189 applies the same punishment to both offenders, the white and the black.

"Indeed, the offense against which this latter section is aimed can not be committed without involving the persons of both sexes in the same punishment.

"Whatever discrimination is made in the punishment prescribed in the two sections is directed against the offense designated and not against the person of any particular color or race. The punishment of each offending person, whether white or black, is the same."

The writer of the article referred to thinks it is a great hardship that one eighth of the people of the United States are prohibited by law from marrying with the other seven eighths.

We think he is mistaken about the fact of prohibition, and that the legal prohibition is very far from universal in the several States. We think, further, that the general sentiment of the negro race, where they dwell in large bodies, is at present opposed to marriage between the races. At all events, such marriages rarely take place where they are legally permitted. Negroes certainly have a higher regard for persons of full blood of both races, and seem in the main entirely unconscious of the injuries which the laws of some of the States are supposed to inflict on them. If the laws are to be changed so they can intermarry in order to elevate the races, why should not some sentimental white people be sent out to Dahomey in order to elevate Africa by the same process?

Let us rest assured of one thing: If the colored race has any virtue in it, it will assert itself. Sturdy integrity, sturdy intelligent industry, and patience, will command respect and will be accorded consideration everywhere. I know of no instance in history where a people has attained eminence without exhibiting energy on its own part. All great peoples have earned their positions. Recognition of the African race, for all it is worth, will come (if it is not now here) in due time.

There is one other matter contained in the article under consideration which ought also to be noticed. It is therein supposed that Congress has power to pass a law declaring the "marriage contract" to be of that kind "within the meaning of the Constitution, which declares that no State shall pass any law impairing the obligation of contracts."

As legal minds are not yet readjusted to the "newer condition of

life" and "a higher civilization," there is an obstacle in the way: The Supreme Court of the United States, and not Congress, is invested with the august power of declaring what the Constitution of the United States means. But this may not be a satisfactory way of looking at the question. Let us take a step further.

A marriage contract, as viewed *by the law*, is only a contract in solemn form between two persons of different sexes, to live together in the state of matrimony until one of them shall die. In this aspect the contract is simply between two persons and binds only two. But another view may be taken: it may be considered as a contract affecting *the public order*, so that the public authorities are to be consulted as to the forms of its solemnization, and the causes and the proof needed for its dissolution.

Laws in force in a State are considered as forming a part of all contracts made during the existence of such laws. We may assume for this country, that there is no State in which it is not fundamental; that the willful violation of a contract in its essential particulars prevents the party who has violated it from enforcing it against the innocent party. Statutes which authorize the setting aside of contracts for their willful violation, or for fraud in their inception, come more properly within the police power, and as touching questions of morals and status, than as laws infringing a sound contract, and such laws are never thought to impair the obligation of a contract in the sense of the Constitution. *The party who violates* the contract is he who impairs it.

He will ask the courts in vain to enforce what he himself has willfully destroyed. So, too, the innocent victim ought not to be bound, where the other party refuses to be bound. But suppose the State steps in and says of the contract of marriage: This matter respects the welfare of the State; it is the interest of the State that the family should not be broken up; the children must have a home; scandal must be prevented, and, therefore, the marriage tie must not be severed.

But here, again, other considerations may be interposed. In ordinary contracts, damages are given the innocent party to compensate for their violation. But money can not atone for the continued desecration of a home or restore a blasted life. Suppose a case where the husband maltreats the wife, and her home is made intolerable and her life a burden. To condemn her to live with the brute is to punish the innocent and reward the guilty. An involuntary life-long degradation worse than servitude is imposed on the unhappy wife for the vices of her husband. Such an administration of law is revolting to our sense of justice.

The above brief suggestions may indicate some of the difficulties which environ the complex questions which "our marriage and divorce laws" evoke.

WOODLAND AND WATER-COURSE.

By HORACE LUNT.

AN interesting exhibition of a swarm of gnats, just out of their pupal state, playing up and down over a particular stone in the wall like jets of water in a small fountain—dispersing instantly as I strike my hands together in their midst, and reappearing over the same stone, again to commence their sport—has engaged my attention, and furnished a side-entertainment, so to speak, until a bird-note to which I had never before listened reaches my ear. At first it is heard at a distance, but, as the singer approaches, the strain is rich and clear, and I become absorbed in the melody. Presently a bird flies from the copse yonder to a tree near by, and, with the positions of serenaded and serenader reversed, pours out a heart-song, in six short stanzas, uttered at intervals of half a minute, which is interpreted thus:

"*Chee—cheer*—cheer—
Chip along—cheer—cheer!"

The words are pronounced with the tongue of a foreigner, it is true, and seem broken; but, considering the artist's recent arrival from Guatemala, he has succeeded admirably in mastering the language. At first, the song is begun in a low tone, as if the musician were doubtful how he might proceed; but, as he advances, it reaches a rapturous climax, and then falls down into the commonplace, ending almost as it began, faltering and inarticulate.

Looking up, I see a spot of white, red, and black among the leaves. Although I have seen the bird at a distance many times, this is my first real introduction to the rose-breasted grossbeak. Knowing what he is after, I seek a covert, to allow him free use of the stream, on the banks of which he soon appears, and, wading into the depths, where is reflected the carmine on his front, scoops up with his deep, broad bill the water needed to clear his throat after such a fine performance. He is a rare minstrel in this woodland, and indeed throughout this part of New England, not more than a pair or two appearing or being established in the same locality, which is generally near a stream of water or in the neighborhood of swampy tracts, for these birds are consummate bathers, and love to have houses with convenient bath-rooms attached.

Passing up the stream, and noting the differently cut patterns of the leaves on shrub and tree, I discover the former home of this singer, situated in the central portion of a high, stout cornel, about twenty feet from the ground. It has certainly been rifled, either by oölogists, young or old, or by the predaceous squirrel; for this is the season of incubation, and not an egg is to be seen.

The nest is composed of rather coarse material, and is very shallow and loosely constructed, somewhat resembling that of the swamp-sparrow, but larger, and not so elaborately built. It being such a simple nest, either the male or female must be on guard to prevent the eggs from rolling out. During the period of incubation, Nature has told the husband to relieve his wife occasionally of the household service, but has evidently forgotten to bestow one apparently essential quality—that is, silence. He is hilarious, even while engaged in his responsibilities, and thus, by his incessant singing, is apt to betray his presence to passing marauders.

The female is dressed in a much plainer suit of brown. Two white stripes, one above and one below the eye, are all she can boast of as head ornamentation, with some sprinkling of saffron about the wings. She is a wise-appearing bird, and does not wear her heart upon her sleeve, like her unwary husband.

It would be interesting to know the circumstances under which Linnæus classified our rose-breasted grossbeak, and gave him the name by which he should be known thereafter to all the nations of the world. The generic *Zamelodia* signifies *singing melody*, which is very appropriate; and the specific "*Ludoviciana*," Louisiana, or relating to Ludovicus. It is likely that Louis XIV was meant, as that King of France took much interest in scientific matters, and invited many of the leading men of science of his day to visit his country. Among them was probably the great Swedish naturalist, who named the bird partly after Louisiana—which was at that time a more extended province than the present State, and where these beautiful songsters are plentiful—partly out of respect for the French monarch, with whom he must have had pleasant associations.

This low ground, where the swamp-roses and tall meadow rue blossom in profusion, is the favorite building-place of the Maryland yellow-throat. Here is one at this moment, the female, moving among the bushes apparently in an anxious state of mind, now darting in and out of sight, now alighting on a twig not ten feet away, her wings quivering with fright or anger, and uttering that peculiar scolding "*chip!*" which expresses so much distress and solicitude, and which has the power and eloquence behind it to arrest your steps for a time, however good your intentions may be in searching for the nest. Surely it can not be far away. The male has arrived with a spanner in his beak, which does not prevent him from chattering his discomfort at my near approach. A small bird he is, with upper parts much the color of the bark of the shrubs; the breast greenish-yellow, with a broad band of black covering the cheeks, and a narrower light one above it. This ornament the female does not have, and she is somewhat smaller.

The application and meaning of the technical term *Geothylpis trichas*, by which the yellow-throat is designated in scientific books,

is, says Coues, "obscure, its only pertinence being in *geo-*, earth, signifying the humility of this bird of brake and brier."

Keeping a sharp lookout, I see the pair flit down among the sedges, the white tops of the meadow rue trembling as they push against the stout stems, and go skulking here and there among the tussocks of rushes where their nest is concealed. Approaching cautiously and tenderly, pushing aside every culm and stem, I at last discover their home, exquisitely placed in a tuft of sedge, some of the spears of which are bent over it so as to form a regular canopy. Ornithologists say that the nest is often built over at the top, with a hole for the entrance. This one has no such contrivance, the thick, overbending sedges answering as a dome and portal. The foundation is composed of dead leaves and coarse grasses, very compact, as if the architects were aware of the dampness of the situation, and had taken the necessary precautions to prevent the eggs from spoiling before hatching-time. The cavity is quite deep and wide for the size of the bird, and has the unusual though sparse lining of horse-hair. There are two eggs in the nest, and, though I read from no authority that the general ground-color should be of a flesh-tint, it is certainly true of these, the larger end being covered thickly with dark purple and brown blotches. Bending the spikes over the nest again, as naturally as a clumsy hand could perform such a delicate task, I went away, trusting that the disturbed pair had comprehended my purpose of merely looking in upon them. But it was of no use ; their nice sense of the proprieties had been disturbed, and a week afterward the ogre had the remorse of gazing into the deserted home from which the songs, confined in their little round prisons, were never to be set free.

The streams and swamps offer more attractive entertainment, at this season, than the dry uplands. Every bird in the vicinity comes here to slake its thirst and bathe. Here is a merry skating carnival of gerris, and a larger party of whirligig water-beetles dodging about in every direction, but never appearing to collide, as they pounce upon the drowning flies, or the twisting, jerking larvæ of the gnat. Down through the thick alders and overhanging sprays of *sambucus* the red-eyed vireo flits from water to twig and from twig to water, striking it with her wings, and sipping it as she flutters over the stream. I am inclined to believe that this may be the manner in which all birds belonging to this group perform their ablutions and quench their thirst. They are not groundlings, and shun the earth as the swallows do the foliage.

Ah ! here is a small flock of chickadees (*Parus atricapillus*), that I have surprised, climbing about on the trunk of this patriarchal willow. The black-capped titmouse is a real Mark Tapley among birds, and actually seems to be less joyous in the midst of summer sunshine and foliage than when the cold winds whirl the snows of winter before his door. How wonderful it is that such a wee bit of a bird

"should come out so strong under circumstances that would make many of the other birds miserable"! One would suppose a good cold breath from Jack Frost would whiff the life from them. It is true they are wrapped in the best kind of overcoats, with black caps drawn over their ears, and good chest-protectors. But what in the world of wonders saves those little wires of legs and claws? What fiery hearts they must have in their breasts, to force the blood-corpuscles through the tendons in the coldest days! What pleasant, convivial, round-headed little fellows they are, calling to one another from their holes in the trees, living on the best of terms with their neighbors, and ar ranging picnic-parties with the blue-jay and downy woodpecker!

By the middle of June all their children have become sufficiently clothed for the summer, and as the season advances they gradually don their flannels for the winter campaign. All that I see now in these woods have thus early in the season formed themselves into flocks, which leads me to believe that they have but one brood in the year. All birds seem to understand each other's alarm-notes, although they may belong to a different genus, and there is something that causes them to congregate from all quarters whenever it is sounded. For birds, like the higher bipeds, are of an inquiring turn of mind, and the same motive prompts them, I believe, to gather at any unusual occurrence in their precincts, which collects a crowd at a fire, or any other excitement, in the streets of a city.

At such times you realize the number and variety of birds that, a moment before, were hidden and silent all around you. Here a female oriole, startled by the close proximity of a meadow-mouse, that like herself has come down to the stream to drink, flies up scolding terribly at the spectacle, and instantly the other birds gather around to inquire the reason of this consternation. The cedar-birds appear suddenly on the spot, silent but observing. The song-sparrow hops upon a twig, from his washing, preens his speckled breast, and curiously eyes his brilliant neighbor. The yellow warbler holds up her head from behind an alder-leaf, and goes skulking through the thick foliage. The indigo-bird looks upon the scene from the lofty spray of yonder elm, and begins a song, when a puff of wind blows him off and cuts it short. The brown thresher, last to come, flies across the opening, flaunts his long tail as he alights on a low branch, and utters a few croaks. Then all is silent as before.

HOW THE EARTH WAS PEOPLED.

By M. le Marquis G. De SAPORTA.

I.

WHY should the study of prehistoric man excite bitter passions? Why should it trouble timorous souls? Its aim, with real scientific inquirers, is simply to attain an objective reality, worthy of the respect of all; and it has had the happy fortune to unite in a common pursuit minds of the most diverse character, having neither the same motives nor the same tendencies, but animated by the pure desire of increasing the domain of knowledge. In this way freethinkers and priests, men of the world and men of the study, collectors, pioneers, philosophers, and practicians, whether spiritualistic and Christian or positivists, resolute partisans of the doctrine of evolution or opponents of it, have labored hand-in-hand in prehistoric investigation—that is, in collecting all the signs, observations, and things which relate to the existence of man in the times anterior to history. The objects of this study also lie back of all chronology, and it is in question whether it is possible to make an estimate of the time within which they were embraced. History, as founded on documents and monuments of definite import and intelligible traditions, goes back to the foundation of the Egyptian empire by Menes, five thousand years before Christ, and there stops. At that time, the Egyptians had an organization, a well-developed civilization, and cities. It is not hazarding too much to add as many years to the figure we have named, or to accept Plato's statement that the Egyptian people were ten thousand years old in his time.

Prehistoric times begin at this period—twelve thousand years ago—and extend back into a much more remote past. Without written data, without even conjectural dates, is it possible to estimate their duration? All that we have are the marks that man has left on Nature, who, in her incessant action burying these marks under accumulations of successive strata, gives us a kind of relative chronology. It is now admitted by science that the life of man crosses the whole Quaternary period, and if we can measure the duration of that period we shall be able to fix approximately the age of our race. This is what M. de Mortillet attempts to do in formulating the conclusions of his book on the "Prehistoric Antiquity of Man."

The circles of growth of trees on American ruins and the rates of formation of river deltas and alluvions have been made the bases of partial and doubtless insufficient calculations from which an age of five or six thousand years has been assigned to the polished-stone period of Robenhausen, and thirteen thousand years for the accumulation of Nile-mud over a brick which was found beneath a statue of

Rameses. The stalagmites of the Kent Cavern, England, which cover both Roman relics and palæolithic implements of the Magdalenian period, have been made the basis of calculations which give an age of more than three hundred thousand years to the more ancient of the deposits. This, of course, is upon the supposition that the rate of incrustation has never been more rapid than it is now. Other calculations are more general in their bearing. The oscillations of the European lands under which Denmark, North Germany, and Russia have been raised from submergence during the Quaternary period, Scandinavia was depressed and has been slowly raised again, and England has been sunk till the connection that existed between it and the continent during the whole Quaternary period has been destroyed, required not less than seventy thousand years. Still another grand and surprising phenomenon, the extension of the Alpine glaciers, by which huge rocks were carried to distances of seventy or one hundred and seventy-five miles, required an enormous length of time. The maximum rate of progress of these blocks is not more than sixty metres a year; but in Quaternary times, when the slopes were not nearly so steep as now, the rate was, according to M. de Mortillet, five times slower, and each erratic block must have taken more than twenty thousand years to be carried from Mont Blanc to the lower Rhône. We may add that an enormous number of blocks were thus transported to form the terminal moraine. Add to the period of extension the period occupied in the retreat of the same glaciers, which must have been nearly as long as the other, and we shall find that the one hundred thousand years which M. de Mortillet asks for to express the duration of the glacial epoch is not an exaggeration. The epochs of the extension and retreat of the glaciers were, however, preceded by a pre-glacial period, and all the calculations together induce M. de Mortillet to adopt a total of two hundred thousand years to represent the entire duration of the Quaternary period, during which we are assured of the presence of man on European soil.

This period, long as it appears, is very short as compared with the myriads of ages of geological development that preceded it, and represents only the last and the shortest of the geological periods. The question arises, How has the human race been able to spread itself over the whole surface of the globe? Is it the product of different and independent origins in the several continents, or have all men sprung from a common cradle, a "mother-region"? On this point students are divided, Agassiz holding that men were created, and Carl Vogt that they were developed, at different centers, and Quatrefages and the theologians maintaining the unity of their origin. The fact is left that man, the same in all the essential characteristics of the species, has advanced into all the habitable parts of the globe, and that not recently, and when provided with all the resources that experience and inventive genius could put at his disposal, but when still young and

ignorant. It was then that, weak and almost naked, having only just got fire and a few rude arms with which to defend itself and procure food, the human race conquered the world and spread itself from within the Arctic Circle to Terra del Fuego, from the Samoyed country to Van Diemen's Land, from the North Cape to the Cape of Good Hope. It is this primitive exodus, as certain as it is inconceivable, accepted by science as well as by dogma, that we have to explain, or at least to make probable; and that in an age when it is only after the most wonderful discoveries, by the aid of the most powerful machinery for navigation, through the boldest and most adventurous enterprises, that civilized man has been able to flatter himself that he has at last gone as far as infant man went in an age that is so far removed from us as to baffle all calculations.

We must insist on this point, for it brings into light an obstacle which those who have tried to trace out the connection between widely separated races and to determine the course that had been followed by tribes now separated by oceans and vast expanses have hitherto found insurmountable; for, if man is one—to which we are ready to agree—we must assign a single point of departure for his migrations. In these migrations, man has gone wherever he could, and, at every spot he has occupied and settled, has acquired characteristics peculiar to the place, and which differentiated him from the men settling in other places. Hence the varieties in human races. Some of these spots seem to have been peculiarly favorable to his advancement, and became centers of civilization. The number of such centers is, however, very limited, and their distribution is significant.

The continental masses are distributed in three principal groups, one feature in the configuration of which must strike every one who carefully examines a map of the world. It will be noticed that they are so expanded toward the north as to touch in that direction or be separated only by narrow passages, and that they also surround within the Arctic Circle a central polar sea with a bordering island-belt. Going down toward the south we find that the three continents, North America, Europe, and Northern Asia, which had approached each other so closely, give place to three appendages, South America, Africa, and Australia, which in their turn gradually taper off to mere points in an illimitable sea, long before they reach the Antarctic Circle. Within this circle the configuration of the land is precisely the reverse of that in the north; it is that of a solid cap of land around the pole, in the midst of the great ocean.

If we again observe these masses, we shall find that civilization was born in each of them under similar geographical conditions, viz., in the neighborhood of a smaller interior sea, near or rather north of the tropic of Cancer, between 20° and 35° north latitude. The most eastern of the centers is in China, near the Japan Sea. The most western, and apparently the most recent, was along the inner shores

of the Gulf of Mexico. The last civilization was in the course of radiation and transformation when the Europeans came to America, and was wholly independent and autonomous; but, weak and relatively new, it was not able to resist the sudden onset of a stronger race.

Toward the center of the space whose extremes we have marked out must be placed two other centers of civilization, more ancient than either of the two already named, and in the same zone of latitude—Egypt, in the valley of the Nile, and near the Arabian Gulf, and Mesopotamia, near the head of the Persian Gulf. Thus, each continental mass had its particular center of civilization, except Asia, which had two—one in the extreme east, the other near the line which joins it to Europe. This peculiar grouping of the chief centers of civilization in such a relation of neighborhood constitutes the most considerable palæoethnic fact that we are able to record. The Nile and the Syrian sea on the west, upper Armenia and the Caspian on the north, the Hindoo-Koosh and the Indus on the east, and the Arabian Sea on the south, bound the region where Cushites, Semites, and Aryans, the first farmers, workers, and founders of cities, the second pastoral people, and the third mountaineers, afterward emigrants and conquerors, met, elbowed each other, and mingled, conquerors and conquered by turns, inventing arts and the use of metals, learning arms and how to organize themselves hierarchically, reaching their ideal through religion, and having in writing the most powerful instrument at the disposition of human intelligence. With them we have the beginning of history, and a continuous chain of social organizations, down to our own days. The growth of civilization in these centers leaves, however, still unaccounted for the diffusion of mankind all over the earth, which took place at a period far anterior to it.

The spread of man throughout Europe and Asia does not offer very great difficulties, for, in consequence of the long distance for which the two continents are joined, Europe is in reality only a dependency of Asia; and occupation of Europe from Asia is conformable to religious traditions. The difficulties are, however, formidable when we come to America, which we find occupied from one end to the other by races whose unity has struck the best observers. Not only, moreover, did the American man inaugurate on the soil of the New World an original and relatively advanced civilization, but he has left, chiefly in the north, indisputable traces of his presence in the most remote ages. Palæolithic implements have been found in the valley of the Delaware, at Trenton, New Jersey, and near Guanajuato in Mexico, so clearly characterized that they can not be mistaken, the situation of which at the base of the Quaternary alluvions and their coexistence with elephants and mastodons, indicate the existence of a race contemporaneous with that of the gravels of the Somme, having the same industry and doubtless the same manners and physical traits. Whence could this primitive American race, sister to the one that lived

in Europe at the same date, have come, unless we suppose a direct communication between the two continents? The difficulty such men would have in crossing the Atlantic and the certainty which soundings give of the antiquity of the ocean remove all possibility of our believing either that the two continents were formerly joined, or that one of them was discovered by some unknown Columbus navigating the ocean a hundred thousand years before the later one.

We are thus in the presence of the problem, always coming up before us, and always escaping us, of the origin of the American man. Evidently it can not be resolved by invoking an accidental colonization of Asiatic wanderers, or a shipwrecked company; but it is one in which we have to deal with primitive populations flowing as in Europe by successive waves, and attesting the continuous presence of man, whose gradual development and extension have followed in America the same course as on the old continent. The hypothesis of an immigration from Asia by way of the Aleutian Islands to Alaska might be acceptable, did not the certainty of the presence of an indigenous American population in the Quaternary age reduce it to the proportions of a secondary fact. The same is the case with the relations—contradictory, it is true, and therefore suspicious—which some have attempted to establish between the monuments, statues, and graphic signs of Central America and those of Egypt and Buddhistic Asia. These analogies, aside from their insufficiency, must fall before two paramount considerations: first, the certainty of the contemporaneousness of the American man with the great animals of the Quaternary age; and, second, the relative uniformity of the copper-colored race, so like itself through the whole extent of the continent, except in that part which is occupied by the Esquimaux. The difficulty arises from the fact that the monogenists, having in view a single birthplace and a single point of departure for the whole human race, and placing neither in the New World, have supposed America to have been colonized by European or Asiatic immigrants following the direction of the parallels of latitude. Emigration in this direction at once meets an obstacle in the oceans, which grow wider the farther south we go. The obstacle disappears if we give up the idea of lateral emigrations, and suppose the movement to have taken place in the direction of the meridians from north to south. No obstacle of any kind offers itself to such migrations; and the relative uniformity of the Americans, from one end of the continent to the other, would never have excited astonishment, if we had not been preoccupied with the idea of their introduction at a later date.

We may remark, on this topic, that the extreme southern points of the three continents are occupied by races which came originally, without doubt, from somewhere else, and which are ranked, in Terra del Fuego, at the Cape of Good Hope, and in Tasmania, among the lowest of the species. These races, advancing in front of the others,

have preserved the visible stamp of the relative inferiority of the stock from which they were prematurely detached. We have to believe, in effect, that these three branches—Fuegians, Bushmen, and Tasmanians—so little elevated in their physical, intellectual, and moral traits, have gone and planted themselves so far away only because the unoccupied space opened out before them. Scouts for the rest of mankind, they have reached, step by step, the extreme limits of the habitable land. They must have occupied for the moment, at least, the parts of the intermediate space, but they could not resist the push of the stronger races, and they could not have survived to our time, except under the condition of restriction to a small area in the most remote tract of their original domain. There is nothing surprising in the fact that MM. Quatrefages and Hamy, having described the most ancient European race of which we have the skulls, that of Canstadt, should have found its analogies only among these same natives of the extreme south—the Bushmen and the Australians.

It will be seen that we are inclined to remove to the circumpolar regions of the north the probable cradle of primitive humanity. From there only could it have radiated as from a center, to spread into several continents at once, and to give rise to successive emigrations toward the south. This theory agrees best with the presumed course of the human races. It remains to be shown that it is equally in accord with the most authentic and most recent geological data, and that, besides man, it is applicable to the plants and animals which accompanied him, and which have continued to be most closely associated with him in the temperate regions which afterward became the seat of his civilizing power.

The general laws of geology favor this hypothesis in a remarkable manner. To make it seem probable, we have only to establish two essential points that will not be seriously contested by any geologist. One is, that the polar regions, which were covered with large trees, enjoyed a climate more temperate than that of Central Europe, and were habitable and fertile to the eightieth degree, underwent a slow and progressive cooling down till the middle of the Tertiary period. Thence refrigeration made rapid progress till the ice gained exclusive possession of the country south of them. Under such circumstances, man as well as the animals and plants would have to remove or perish —to emigrate step by step, or find himself reduced to a daily more precarious state of existence.

The second point is the relative stability of the existing continental masses, and of their distribution around a sea occupying the Arctic pole; while the other pole was occupied with a cap of land surrounded by an immense ocean. The importance of the Arctic pole in respect to the production of animals and plants, and to their migrations, and the nullity of the other hemisphere in relation to this feature, result from such a grouping. The essential point is, that there is nothing

capricious in such an arrangement of lands and seas, and that there have been, if not always, at least from a very ancient period, emerged lands occupying a considerable part of the northern hemisphere, advancing very far toward the pole, and describing around the Arctic Sea a belt of more or less contiguous countries and islands. This is, in effect, what geology teaches. The changes, immersions, and emersions have never been anything but partial and successive, while the skeletons of the continents go back to the most remote ages. There have always been a Europe, an Asia, an America, and Arctic lands. We know certainly that there have always been around the Arctic pole extensive territories, if not continents, long the home of the same plants as the rest of the globe, and that, beginning with an epoch that corresponds with the end of the Jurassic, the climate, at first as warm there as elsewhere, has tended gradually to become colder. The depression of temperature was at first manifested very slowly, and was far from having attained its present degree in the tertiary ; for the trees that then grew in Greenland—the sequoias, magnolias, and plane-trees—now attain their full development in Southern Europe, and are not suited with the climate of Central Europe. We are, then, assured of the ancient existence, near the Arctic pole, of a zone of lands covered with a rich vegetation. The permanent existence of a polar sea is none the less attested by fossils from all parts of the region. The neighborhood of the pole was long habitable, and inhabited by man in a time near that in which the vestiges of his industry begin to show themselves alike in Europe and America. In passing thus from the Arctic lands to those bordering on the polar circle, and through the latter into Asia, Europe, and America, man would only have taken the road which a host of plants and animals followed, either before him or at the same time, and under the stress of the same circumstances.

It is, in fact, by the aid of migrations from the neighborhood of the pole that we can generally explain the phenomenon of scattered or disjoined species, a phenomenon identical with the one which man of the Old World and man of the New World present when they are compared. Combining present notions with the indications furnished by the fossils, we discover numerous examples of disjunction—in which allied forms, often hardly distinguishable, have been distributed at the same time in scattered regions, at extremely remote points in the boreal hemisphere, without any apparent connection along the parallels, to explain the common unit. Europe attests by undeniable fossils that it had formerly a host of vegetable types and forms that are now American, which it could have received only from the extreme north. It had, for example, magnolias, tulip-trees, sassafras, maples, and poplars, comparable in all respects to those which grow in the United States. The two plane-trees, that of the West and that of Asia Minor, to which we may add an extinct fossil European plane-tree, illustrate the same phenomenon of dispersion. Europe in the Tertiary period

witnessed the growth of a ginko similar to the one in the north of China. It had sequoias and a bald cypress corresponding with the trees of those names that are now growing in California and Louisiana. The beech seems to have been growing in the Arctic circumpolar zone before it was introduced and extended throughout the northern hemisphere. The same is doubtless the case with the hemlock, of which distinguishable traces have been found in Grinnell-land, above the eighty-second degree of latitude, of a date much earlier than that of its introduction into Europe. The well-established presence in both continents of many animals peculiar to the northern hemisphere must be attributed to emigrations, if not from the pole, at least from countries contiguous to the polar circle. This is obvious in the case of the reindeer, bison, and stag; but it ought to be equally true in respect to animals of more ancient times, and, although we have no other direct proofs of it than the abundance of the remains of mammoths in upper Siberia, the same law doubtless includes the elephants and mastodons. We mean here the species of these two genera which were propagated from the north to the south, and were, in America and Europe, the companions of primitive man. The connection of the continental masses with their belt of hardly discontinuous lands around the polar circle gives the key to all these phenomena. The cause on which they depend would be constantly producing radiations and consequently disjunctions of species and races, whatever kingdom we may consider.

Before leaving the questions that touch on the presumed origin of man, we can not refrain from speaking of the relations which it has been sought to establish between him and the pithecan apes. Primitive man, according to some authors of the transformist school, was an anthropomorphic ape, perfected physically as to his walk and erect attitude, intellectually by the development of his cranial capacity, till the moment when reasoning, or the faculty of abstraction and the power of using articulate language, took in him the place of instinct. Numerous and undeniable anatomical or physiological analogies of the human body and those of the more highly organized monkeys, which have no tails nor callosities on their paws, and whose faces and ways have something singularly human, favor this system, at least in appearance. The pithecans have, however, other contiguities than purely human ones. Their ways are rather analogous than directly assimilable to those of man; with other adaptations, they seem to have followed a wholly different course of evolution. They are essentially climbers, while man is exclusively a walker, and has always been predisposed to the erect position. The highest monkeys, the anthropomorphous apes, walk badly and with difficulty. When they leave the trees in which they live, their position is a stooping one, and they bend down their toes so as not to touch the ground with the soles of their feet. We have, then, reason not to admit the simian origin of man

without decisive proofs. Moreover, the pithecans seem to have been evolved in an inverse direction from man. Rejoicing in the heat, they perish rapidly when brought into the temperate zones, and this is especially the case with the anthropoid apes. Thus, while man, coming from the north, advances toward the south only when the depression of temperature favors his progress in that direction, the monkeys, to which a strong heat is a vital element, were developed in an age when Europe had a sub-tropical climate, and disappeared from that continent as soon as the climate became temperate, so that their departure coincides with the arrival of man. They fled south to find the heat they needed, precisely when the diminution of the heat opened to man the region from which it excluded his predecessors. The necessity of placing the cradle of the pithecans in a hot country enables us to separate the monkeys of the Eastern and Western Continents into two distinct groups marked by differences in dentition important enough to oblige us to assume an extreme antiquity for their separation. Both are descended from the lemurians, now represented only in Madagascar, but of which early tertiary fossils are found in Europe. The most recent lemurians in Europe are found at the end of the Eocene. It is later, in the Miocene and that not the lowest, that we meet pithecans similar to those of the equatorial zone of the Eastern Continent. At this epoch, which was nearly that of Oeningen and the Mollassic Sea, which divided Europe from east to west, a sub-tropical climate still prevailed in the center of the continent, and the palm-trees extended up into Bohemia, along the northern banks of the great interior sea. By favor of this temperature the monkeys occupied Europe to near the forty-fifth degree, but without going above it, to disappear forever as soon as it became cool enough for men and elephants.

The *Mesopithecus Pentelici*, of which M. Gaudry has discovered twenty-five individuals at Pikermi, was small, walked on its four paws, and lived on twigs and leaves. The *Dryopithecus* of St. Gaudens had the characteristics of the highest anthropomorphs, with the bestial face of the gorilla; but it is to this animal that M. Gaudry is inclined to attribute the flints, intentionally chipped, according to the Abbé Bourgeois, of the Beauce limestone at Thénay, in the St. Gaudens geognostic horizon. The *Pliopithecus* of Sansan (Gers) resembles a gibbon. To find the present analogues of the *Pliopithecus* and *Dryopithecus* of Miocene Europe, it is necessary to go across the tropic of Cancer to about 12° north latitude, or more than thirty degrees south of the locality of these fossils. If, as is probable, the same interval existed between the perimeter frequented by the European anthropomorphs and the natal region in which man was originally confined, we shall find the latter in the latitude of Greenland, at 70° or 75°. This is indeed an hypothetical calculation, but it is based on a double argument hard to refute.

We can reach almost the same conclusion by a little different reasoning. The abundance of large-flaked instruments in the contiguous valleys of the Somme and the Seine marks the existence at that point of external conditions evidently favorable to the diffusion of man, whose race was then multiplying for the first time. The flora of that epoch, as observed near Fontainebleau, indicates the presence of conditions similar to those now existing in the south of France, near the forty-second degree of latitude. Now, to reach, starting from the forty-second degree, the nearly tropical regions where palm, camphor, and southern laurel trees are associated together, we have to go twelve or fifteen degrees south, to the thirtieth or twenty-eighth degree of latitude, where we see the same climatological conditions existing as prevailed in Miocene Europe when it was hardly warm enough for the anthropomorphic apes. Between these conditions and those which seem to have been first favorable to the growth of the human race, there existed a space of twelve or fifteen degrees of latitude. But when palm-trees were growing near Prague, and camphor-trees grew as far north as Dantzic, man, if he existed then, might have lived without inconvenience beyond or around the Arctic Circle, within equal reach of North America and Europe, which he was destined to people. If it be objected to this view that man now lives in the hottest regions as well as in temperate ones, we answer that that shows simply that he has developed a capacity of adapting himself to them; but he flourishes best and has reached his highest development in temperate latitudes.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

PRIMITIVE MAP-MAKING.

By GEORG M. FRAUENSTEIN.

THE idea of representing the surface of the earth, or even a part of it, by a map, implies a considerable advance in knowledge. Every map, even the crudest one, is in a certain sense a concentrated representation, a kind of distillation of physical and politico-geographical knowledge. The clearer and more comprehensive this knowledge, the higher is the degree of accuracy with which it can be portrayed. We are not only taught this by the history of the peoples with which we have had the most to do, that is, of the civilized nations, but it is obvious to any one who is acquainted with the lower races. The same practical reasons which urged Europeans to the pictorial representation of geographical facts have also made their influence felt in the prairies of America and the islands of Australasia; and I have seen maps prepared by Polynesian or Indian hands that would compare favorably with mediæval representations of the same kind.

As a rule, cartography begins with road-maps. Peoples whose territory is a terminating point or is traversed by important trade-routes, and who perform a carrier-service, are accustomed as a matter of course to learn to depend upon drafted representations of their roads. Appolonius Rhodius says that such maps were used by the ancient Colchians of the Southwestern Caucasus and Northern Armenia, through whose territory ran the great caravan routes from the Black Sea to the East and South. Herodotus and Xenophon describe the great post-routes of the Persians, over which the royal orders were carried to all parts of the kingdom, as systematically laid out and provided with stations and inns, and arrangements for changing horses. The caravan-roads now mark the most practicable routes for railways; and the French might make good use of the itineraries of the Tuaregs in laying their tracks across the Sahara, if they were only accessible. That the sons of the desert, who are able to speed with unerring accuracy for hundreds of miles across the ocean of sand, possess at least the capacity to make a representation of their route, is shown by the statement of Duverrier, that the Sheik Othman drew in the sand for him a plan of the central range of Hoggar.

The accounts that have been given of the map-making of the negro races have a still higher interest for us. Stanley says that the Waganda frequently have recourse to drawings which they make upon the ground to render their imperfect verbal descriptions more clear. The sand of the sea-shore has, in fact, played a very important part in the beginnings of cartography. Travelers of widely different periods, whether speaking of the German coasts or of the shores of America and Asia, have made the same observation, that the coast people, in order to give a more distinct answer to any question about the roads and paths, have spontaneously made drawings in the sand of the stretch of country they were talking of. Examples in point may be cited from the Baltic coasts, from the Island of Jesso, and from Northern Siberia. Ainos and Tunguses have directed travelers in the same illustrative way.

The more intelligent ones divide the roads which they would represent into days' journeys, and designate mountains and islands with little piles of sand, and towns and fishing-stations with sticks. Kotzebue, Chamisso, and Beechey tell stories of the same kind of peoples of the great ocean. The inhabitants of Tahiti and the Marshall Islands give, by means of stones arranged on the beach-sand, a clear view of whole groups of islands, between which they point out the navigable channels. The islanders have also a kind of portable maps of their own designing, showing, by means of strings with knots tied in them, the direction of the principal currents. According to Captain F. H. Witt, the Micronesians of the Caroline and Marshall Islands make a frame of ribs of palm-leaves, across which they weave the blades to serve as the foundation for their map. The islands are then represented

by fastening at the proper places shells or pebbles of sizes proportioned to the magnitude of the islands to which they are intended to correspond.

In some of the Australasian islands the tattooing of the body is made to bear a geographical significance. Lütke remarked in 1828 that on some of the Caroline Islands the chiefs had lines tattooed on their bodies, with each of which they associated the name of some island or group. Thus, these savages carried around with them on their own persons geographical directories that could not be lost—certainly one of the most original geographical and mnemotechnic devices of which we have any record.

These incidents point to a peculiar capacity or sense of the relation of directions on the part of the people of the islands of the great sea, which is manifested in many different ways. These people do not have the materials which we use for such purposes; but, when they are furnished with them and have learned to use them, they soon acquire facility in making maps according to our ideas. Their capacity to accomplish this can not admit of dispute, when it is remembered to what immense distances they are able to go straight with their little narrow canoes. Every European seaman must admire the skill of the Caroline-Islanders, who succeed in traveling with such sureness over the length and breadth of their group, through spaces in which one of the islands may be more than eight hundred miles from its neighbor. There are numbers, not of theoretical geographers, but of practical sailors, who are acquainted with the islands, and have observed the achievements of the natives, who will bear me out in this. There are now in existence a few maps made by Polynesians with European writing materials that afford a permanent testimony of the clearness of mind with which these "wild" people control their sea-voyages. The most famous of them is the one made by Tupaya of Tahiti, a man who went with Cook on his first voyage through the main part of the Australasian Archipelago. It comprises not less than forty degrees of longitude, extending from the Panmotu Islands in the east to the Feejee group in the west. While the most striking feature of this work is the great extent of what is correctly and plainly set down, some New Zealand maps attest the special knowledge the makers had of the details of their native land. One of these was compiled in 1798, before any European colony had been founded in New Zealand; another was published by Shortland in 1854.

The Esquimaux have contributed important service to the enlargement of knowledge by the aid they have given to the older and the more recent explorers, from whom their achievements in cartography have received special praise. They have supplied European and American sailors with most valuable directions by drawings on both sand and paper. They are accustomed to designate with great care all the projecting points of the land, even the smallest ones, but all of their

works have an important defect, which strikes the eye at once. They can not comprehend the great changes in the trend of the land toward the different points of the compass; but represent everything as running generally in the same direction. The student must, therefore, make himself accustomed to this straightforward mode of projection, in order to understand them aright. Abundant evidence, nevertheless, exists of the value of these maps in perfectly unknown regions. C. W. Parry acknowledges his obligations to a remarkable Esquimau woman, Iligliuk, for a map by the aid of which he discovered the Fury and Hekla Straits, sailing north from Hudson's Bay. Dr. I. I. Hayes speaks of a rude map of the coast from Cape York to Smith's Sound, on which all the inhabited places of Western Greenland were marked, that was made for him by the guide Hans. Franklin states that in his second voyage the Esquimaux, when inquired of, drew the outlines of the coast on the sand, divided it off by days' journeys, indicated the islands and their size and shape by heaps of gravel, marked the mountains with sand and stones, and inhabited places with sticks, and exhibited so much anxiety to be correct as to consult with each other on points respecting which any of them had doubts.

An autograph map by an Esquimau of his own home may be seen in the Royal Hand-bibliothek at Stuttgart, where it is catalogued under the name of "Niakuntigok"; and I have noticed other drawings of Esquimau maps in Hall, and in the journal "Globus" for 1877.

Drake, in his "Book of the Indians," gives several examples of maps by the North American aborigines. The efforts of these people are of interest enough to deserve a more special account. Drawings in the sand are frequently mentioned as made by them; as, for example, by Mackenzie, by Lieutenant Whipple of the Kiowumis, and by Captain J. Jacob of the Haidas on Vancouver Island. The Indians have not, however, rested satisfied with these primitive methods of representation, but have, like some Esquimaux and Polynesians, made the great step of the discovery of portable maps, and have even made more advanced efforts in this art, and far more extensive applications of it, than the others. Their maps furnish correct data with reference to the roads and coast-lines, and also to whole districts, with the rivers, mountains, towns, and the connecting roads, and have the days' journeys carefully marked on materials of the most diversified character. Heckewelder and De Smet describe maps that were made with ashes and coal on pieces of bark and deer-skin; Hunter saw in Carolina plans of whole districts on the blankets of the chiefs, with the boundaries of the different hunting-grounds carefully marked off. The chiefs of many tribes were in the habit of keeping portable maps filed, and already attached great value to them when they first came in contact with Europeans, certainly before they had had an opportunity to learn the use of maps from them. Travelers of the seven-

teenth and the beginning of the eighteenth centuries, among them Le Clerc, La Hontan, and Lafiteau, attest this fact with a host of examples, and other notices of such maps are given by Copway and Schoolcraft.

A much greater advance in map-making had been made in Mexico and Central America centuries before the European immigration. The whole Aztec kingdom was registered and mapped off at the time the Spaniards came into the country. In the plat-books the crown-land was colored violet, the land of the nobles red, and the common lands yellow; and the plats were so carefully executed that they were to a certain extent accepted as evidence under Spanish rule. These books, a remarkable result of a highly developed civilization in an Indian state, were of great importance in processes, and it is possible to obtain satisfactory information from them even now. Thirty-six of the registry-maps are still left in the "Codex Mendoza"; Alexander von Humboldt publishes in his "Atlas of New Spain" a representation of a carefully delineated estate concerning which an action was brought; and Brasseur de Bourbourg and Prescott speak of maps in the archives of the Aztec princes, which represented in regular order the mountains, woods, rivers, cities, boundaries, roads, and coast-lines, and contained valuable statistical and other information on their margins. Alexander von Humboldt saw, in the hands of a native of a town near Tetlama, a geographical map that had been hidden in the woods from the Europeans, which was made before the landing of Cortez. The conquerors of Mexico themselves received from the king a plan of the coast with its rivers and capes painted on cotton cloth, and from the natives another map that indicated all the rivers, mountains, and large towns from Xikalanko to Nicaragua. A fragment of a very interesting historical document still exists in the library of the city of Mexico. It is the ground-plan of Tenochtitlan, the estate in which Montezuma II entertained his guest Cortez, and which the latter knew so well how to plunder. Bullock saw it, and had a copy taken of it, in 1824. Aubin had in his possession, in 1860, twenty-five leaves of the Mexican land-register, with portraits of the kings of the last period of independence, and texts added from the years 1539, 1573, and 1599, with what is more important for us, three maps by the last Aztec prince, Guatemozin. It was copied at his command, in 1533, from older maps, and contained data from 1361. Three other maps of the same brave but unfortunate ruler, which go back to 1438, were copied in 1704 by the royal Spanish interpreter, Manuel Mancio. Finally, Peter Martyr describes a similar map, painted on white cotton cloth, that was not less than thirty feet long.

Squier and Davis state that the Toltec states—Nicaragua, for instance—had books written on deer-skin, in which were marked by the elders of the towns, in black and red, the boundaries of the districts, the rivers, lakes, woods, and even single estates. In Peru relief-maps

were made with skillfully drawn lines, and impressed with stone, clay, and straw. Garcilasso de Vega, in his "General History of Peru," composed at the beginning of the seventeenth century, gives a well-drawn plan of the city of Cuzco, with representations of the streets, squares, and brooks, which was made at Muyna; and he tells also of representations of entire districts. The beauty of these works is attested by several Spanish authorities. Balboa speaks of a plan of the besieged fortress, Pomacocha, which was sent to the war council at the capital. Bastian had made for the Royal Museum in Berlin a copy of the plan of an ancient Inca city which he saw at Cuenca, a picture of which was published in the "Zeitschrift für Ethnologie," in 1877. The squares and public places and the royal palaces were indicated by the arrangement of blocks of wood.

The Polynesians, the Esquimaux, and the Indians, have all thus given us the marks of the different degrees of advancement they have independently made in the use of this, the most important of geographical aids. In their ignorance of the art of writing, and their want of suitable writing materials, they have made use of the same primitive methods as the people of the German coasts still employ. When the progress from tribal communism to a formulated state-life and the transition from trivial, groping essays to a public provision for a system of written records are consummated, well-executed maps appear among the evidences of the degree of civilization that has been reached.—*Translated for the Popular Science Monthly from Das Ausland.*

THE GRANULE OF STARCH.

BY AN ANALYST.

THERE may not seem much in a grain of starch, and in point of bulk there *is* very little; but we shall endeavor to show that there is a good deal of interesting and valuable information to be derived from a careful study of the little granule.

We are all familiar with such commodities as flour, potatoes, Indian corn, sago, peas, and arrowroot, and are consequently to some extent acquainted with what starch is; for all these substances consist essentially of starch, along with water and some minor admixtures. If we take a slice of a potato, for instance, and rub it on a grater of any sort in a basin of cold water, the water will soon become turbid; and a drop of it examined with a microscope will be found to contain a number of minute oval granules, which would in time sink to the bottom of the basin, forming a white deposit. These are grains of starch; and so minute are some varieties that three thousand of them laid end to end would barely make an inch.

The starch of every plant differs from its neighbors both in size and shape, and this has a considerable influence on the character of the vegetable organ in which it is stored up; the hardness of rice, for instance, being due to the fact that rice-granules are extremely minute, with angular corners which fit closely and firmly together; whereas potato-starch is large and round, with considerable interspaces filled with water, and so forms a comparatively soft mass. But, notwithstanding their outward points of difference, in chemical composition the starches are all identical, consisting of carbon, hydrogen, and oxygen—exactly the same materials as sugar is composed of, and better known as the component elements of coal and water. Leaving the many varieties of starch in the mean while, let us consider one species, namely, that of wheat, because it is the most important in this country, forming the basis of our daily bread.

An ordinary grain of wheat, if sliced through the middle and examined as to its structure, will be found to consist of several layers, the outer a hard coating, which contains mineral salts, lime, sand, etc. Beneath this is a zone of matter very rich in gluten, the flesh-forming constituent of the wheat; while the central portion of the grain is occupied by a white, powdery mass, which is nearly pure starch. In manufacturing flour, the two outer layers, which together form the bran, are usually removed, leaving the white starchy flour of the central portion.

Let us now briefly consider the chief points in the chemistry of bread-making. If flour be worked up with water, it forms a sodden, insipid, indigestible mass; but, if heated to the temperature of boiling water, the starch-granules burst; and it is thereby rendered a little more digestible, although still forming a close, stiff, and not very palatable cake. Such is the character of unleavened bread, and of sea-biscuits, a slightly different form of the same thing. To be fit for digestion, starch must be dissolved or softened by boiling or baking; hence the reason why raw nuts are so indigestible as compared with the favorite roasted chestnuts; and hence one reason for cooking food, which mankind has been taught by experience, ages before chemistry could give a scientific explanation of the reason why. Cooking is, in fact, a partial digestion; and the same is the case with baking, both being preliminary aids to the changes which take place in the mouth and stomach before the food is in a fit state for the preparation of the blood. Accordingly, we bake our bread; and we bake it in the way we do because a soft, spongy loaf is more readily moistened and acted on by the saliva and the juices of the stomach.

There is a good deal in the chemistry of bread-making; and our bread might be much improved if bakers had a more intelligent understanding of the science involved in their business; for, although several improvements have been introduced of late years, the most of our bread is still prepared in the old fashion. The necessary quantity of flour is

put into a trough with about half its weight of water, and sufficient salt and yeast or leaven, then thoroughly mixed up into what is known as the "sponge." (Here we may remark that the best flour takes up the largest quantity of water; and a rough test of the quality of two samples of flour may be made by comparing the quantity of water required to obtain a dough of similar consistency.) After the sponge is made, it is left for about five hours in a warm place to ferment, after which it is kneaded with the rest of the flour, and again left to rest some time. The dough is then weighed into lumps, which are put in tins, and set aside till they have risen to twice their previous bulk. It is to the yeast or leaven that the raising of bread is due, and the action is identical with that of the fermentation of beer. The flour contains a small amount of a nitrogenous substance which changes a portion of the starch into sugar; the yeast then attacks the sugar, splitting it into alcohol and carbonic-acid gas, the little bubbles of which try to escape from the mass of the dough, but get entangled by the gluten and gum which the flour contains; and thus every part of the bread becomes penetrated with little cavities. Eventually the fermentation would cease, and the bubbles of gas would find their way to the outside, thus leaving the dough much less light and spongy than we wish it to be; but the baker guards against this by putting it at the proper time into a hot oven, the heat of which at first increases the fermentation. In a few minutes, however, the temperature becomes sufficiently high to kill all the yeast-germs; the fermentation is thereby stopped; and, by continued heating, the starch-granules are burst and the mass is fixed in the porous form it has then attained. A little of the alcohol is retained in the bread; but practically almost the whole of it—in London amounting to some three hundred thousand gallons per annum—is driven off by the heat. During the baking, the starch of the outer portions of the bread has been browned by the heat, and thereby changed into a sugar known as dextrine or British gum; and perhaps this fact accounts for the fondness of some children and even grown-up people for crusts.

Of late years a system for making what is called aërated bread has proved very successful, and is free from the slightest objection. The dough is made by mixing the flour with water saturated with carbonic-acid gas, which on heating is expelled from the water, and thus distends the dough, producing a light, spongy bread, with no loss of starch or sugar, and without any injurious or objectionable ingredient having been introduced.

Having dealt with the baking of the bread, let us now briefly consider its further progress in being adapted for the wants of the body. As soon as a piece of bread is put into the mouth, an abundant flow of saliva takes place; and in fact it needs no actual tasting to induce this flow, for even the sight or smell of anything nice is quite sufficient to "make the mouth water," as we express it. The saliva is poured into

the mouth by three pairs of glands to the extent of some twenty ounces a day. It consists in great part of water, with a little salt and a peculiar substance called ptyaline, which possesses the property of changing starch into sugar, the change being accomplished most completely when the starch is dissolved or baked, at a temperature of about 98° Fahr., the normal temperature of the body. Although this ptyaline is present in the saliva to the extent of only one part in five hundred, yet, on its presence and action, the heat, and consequently the life of the body, is largely dependent; hence the importance of avoiding any unnecessary waste of it, such as frequently and unnecessarily accompanies smoking. Hence, likewise, we see the importance of chewing the food slowly and thoroughly, that it may be all brought under the influence of the ptyaline; and thus we can understand how indigestion or dyspepsia may be caused by hasty chewing or by excessive spitting, the starchy portion of the food in either case lying in the stomach as an undissolved mass.

Bread-making we have already stated is a form of cooking. The heat of the oven has converted the outside of the bread into sugar, and the starch in the inside has in fact been boiled in the steam of the water which the dough contained, so that it has become capable of being readily converted into sugar. The porous nature of the bread favors this conversion; for the saliva easily penetrates through the whole of the spongy mass; and the change is still further assisted by the water which the bread contains to the extent of some forty per cent. Biscuits, on the other hand, being as a rule dry and non-spongy, are less suitable for ordinary use, although containing in the same weight far more food-material than bread.

It may surprise some of our readers to be told that the starch of bread has not the slightest nutritive property. Its sole office is a heat-producer; and, just like the coal of the engine, the starch or sugar is burned up inside us to keep up the temperature of the machine. It is the gluten, the sticky, tenacious matter in the grain, which is the nutritive, flesh-forming material; but in the present article we have no space to follow the changes which *it* undergoes in the system, for we are simply treating of starch at present; and we trust we have made it clear how it is changed into sugar, and thus made soluble and fit for absorption into the juices which keep the body at a uniform temperature and in good repair.

It is a common but mistaken notion that sago and tapioca are very nutritious. On the contrary, they consist almost wholly of starch, with only about three per cent of gluten, so that, unless cooked with milk or eggs, they form a very insufficient food. The same is the case with Indian-corn flour and arrowroot, which have scarcely a particle of nutritious matter in them, so that it is a great mistake to feed an invalid or a child on such materials. They are no doubt useful, as easily digested heat-producers; but they must be cooked with milk or

eggs before they are of much use for actual nutriment; and many a child has been starved to death through its parents' ignorance of this fact. It is true, medical men often recommend arrowroot for those in delicate health, as it is of great importance to keep up the natural heat of the body with the least exertion of the digestive organs; but it can not be too widely known that arrowroot pure and simple is a mere heat-producer; and milk, beef-tea, soup, or other suitable flesh-forming food, must be given with it, if the child or invalid is to be kept alive. On the other hand, semolina, hominy, lentil-meal, pea-flour, etc., not being prepared by washing, contain a much greater amount of flesh-forming material than sago, arrowroot, etc.

The starches are largely used in several important manufactures. Dextrine or British gum is prepared by heating starch to a temperature of about 400° Fahr., and is preferred to gum-arabic because it is not so liable to crack or curl up the stamps or other paper prepared with it. Immense quantities of starch are used, too, in the manufacture of glucose or grape-sugar, which has exactly the same composition as starch, and is prepared by acting on the starch with sulphuric acid (oil of vitriol), which has the same effect as the ptyaline of the saliva. Linen rags are largely used for the same purpose, too; and, indeed, it is wonderful how few things are altogether useless at the present day. Old boots and horns provide some of our most brilliant colors; while dye-colors innumerable are made from the refuse of out gas-works; and the wash-heaps of our factories are proving mines of wealth, instead of mounds of rubbish.—*Chambers's Journal.*

SKETCH OF SIR WILLIAM E. LOGAN, LL.D., F.G.S.

JAMES LOGAN, the grandfather of Sir William, came to Montreal from the parish of Stirling, Scotland, about 1784, bringing his wife and two sons. He established himself as a baker in that city, the occupation he had followed at home, and was assisted in the business by his older son William, then a young man. After a few years, Miss Janet E. Edmond came to Montreal from Scotland, and was married to her cousin William. The third of their nine children, WILLIAM EDMOND LOGAN, the subject of this sketch, was born April 20, 1798. The first school to which he was sent was one kept by a Scotchman in Montreal; but, in 1814, he and one of his brothers were sent over to Scotland and placed in an advanced class in the Edinburgh High School. The studies of the school were mainly classical. During his two years here, young William was much of the time "dux" of his class, and won several prizes. In the mean time his father, leaving his oldest son to manage the business in Montreal, had removed the

rest of the family to Edinburgh. During the academic year 1816–'17 William attended classes in logic, chemistry, and mathematics, at the University of Edinburgh. He continued here the diligence which he had manifested at school, and carried off the first prize in mathematics, "with the good-will of all the competitors."

Preferring to enter mercantile business rather than to continue longer at the university, he went to London in 1817, being then nineteen years old, to take a position in the counting-house of his uncle. But he did not give up literary pursuits, for, in a letter written to his brother in Montreal a few months later, he thus describes his avocations: "Part of the day I read Italian and French, write versions in those languages, and generally in the evening translate 'Gil Blas' with Alexander Gillespie, Jr., who, by-the-by, is the greatest companion I have here. Now and then I have a look at Homer and Cicero, and mathematics is not neglected. Indeed, I carry on a correspondence with one of my fellow-collegians, Mr. Cockayne, who resides in the north of England. He sends me propositions, which, after having solved, I return to him with the demonstrations, annexing at the same time propositions to exercise his knowledge of geometry. This, in my opinion, is a rational and useful means of keeping up an acquaintance. Sometimes the flute amuses me, and I hope you have not given up playing on that instrument." In his younger days, as his biographer tells us, Logan was an excellent correspondent. "But, not satisfied with writing often himself, he frequently urges his brothers or sisters to do likewise, and sometimes, by way of encouragement, praises the letters which he receives. . . . In this way, and by regularly causing the letters which he himself received to circulate among other members of the family, he aided in keeping alive that union and interest in family affairs which so often cease when the children grow up and become scattered."

Young Logan had abundant opportunities to gratify his musical tastes while in London, and his years there seem to have passed very pleasantly. He lived in his uncle's family, until the latter gave up his London residence, but he seems to have welcomed this change as giving him a chance to devote more time to business and to lead a quieter life. In 1826 he made a short visit to Paris, and wrote to his brother James some very lively impressions of the faculty for display of the French people.

A few years later, Logan's uncle became interested in mining and smelting operations in Wales, and young Logan was sent down to keep the accounts of the establishment. "But you may be assured," he writes, "I shall spare no pains to make myself master of every branch of the business; and, as it is of a scientific nature, I am pretty sure I shall like it." The study of the minerals with which his business was directly concerned—copper and coal—awakened in him an interest in mineralogy and geology. He studied the question of how

the coal-seams were formed, and devoted a large share of his scanty leisure to making a geological map of the district. His drawings were offered to Sir Henry de la Beche, when the latter began his government survey in that region, and Sir Henry gladly availed himself of them, giving due credit to Logan. While he remained in its vicinity, Logan did much for the museum of the Royal Institution of South Wales, and held the positions of Honorary Secretary and Curator of the Geological Department. He presented to it valuable collections of minerals and metallurgical products, laboratory apparatus, drawings, and a collection of Canadian birds. Logan rapidly became known among British geologists, and in 1837 was elected a Fellow of the Geological Society. The next year his uncle died, and Logan gave up his position in the Morriston copper-works.

The problem of the formation of coal-strata, which had engaged Logan's attention, was at this time far from settled, one party firmly maintaining that the carbonaceous matter had collected as drift-wood collects; another, that the seams were deposited like peat in the swamps. "In these circumstances," says his biographer, Professor Harrington, "Logan had the sagacity to observe and turn to account a fact which has settled forever the question of the origin of coal, in favor of the theory of growth *in situ*. Under eighty or more coal-seams, which occur in the Welsh coal-field, the miners had observed the invariable presence of a bed of more or less tenacious and bleached clay, which they called the 'under-clay' of the coal, and which was often of practical importance as affording facilities for under-cutting the coal. The constancy of this fact Logan confirmed by his own observations, and added to it the further and important discovery that in all these under-clays there occurred abundance of remains of the peculiar plant known as *Stigmaria*, in such circumstances as to show that the plant was *in situ*, and not drifted. In February, 1840, Mr. Logan communicated his results to the Geological Society of London, in a paper entitled "On the Characters of the Beds of Clay immediately below the Coal-Seams of South Wales."

In his letters from Wales to his brother James, Logan had repeatedly asked for specimens of the Canada minerals, and had expressed the wish to examine for himself the rocks of his native region. Accordingly, in the summer of 1840, he left England for Canada. During his year's visit to America, he made geological studies in the neighborhood of Montreal, in Maine, and, just before his return, visited the coal-fields of Pennsylvania and of Nova Scotia. The results of two of his investigations he embodied in a paper entitled "On the Packing of Ice in the St. Lawrence, and on a Land-Slide in the Valley of the Maskinongé," which he read before the Geological Society of London in June, 1842. From the parts of this paper quoted by Thomas Keefer in his "Report on the Bridging of the St. Lawrence," George Stephenson is said to have obtained useful hints in

regard to the site for his Victoria Bridge. His visits to the coal-fields were eminently satisfactory, for he found in every case the under-clay showing plenty of remains of *Stigmaria*. While on this trip he met Lyell, and had the pleasure of learning that that distinguished geologist was acquainted with his work, and deemed his results important.

The first Parliament of the united provinces of Canada in 1841 voted £1,500 for a geological survey. Logan was then in England, but his friends in Montreal, who had heard him express a desire to do this work, proposed his name to the Governor for director of the survey, and in the next year he was tendered the appointment. Then followed twenty-seven years of devoted labor in the almost untrodden field of Canadian geology. After two seasons' work Logan submitted a report of progress, the first of a series of sixteen government reports. The money for the survey was voted in small annual grants, and for short terms, and more than once was Logan obliged to talk and write almost constantly, for several months, to members of the Government, explaining and demonstrating to them the importance of carrying on the work. The first of these critical periods occurred in the winter of 1844–'45, when the first grant of £1,500 had been expended, together with over £800 of Logan's money. Finally, £2,000 a year for five years was granted, and, at the end of the time, the grant was renewed for five years more. An act in 1855 appropriated twice as much for the next five years, but this was afterward somewhat reduced. It required a large measure of courage and devotion to plunge into this work so earnestly as Logan did. "Of the topography of the Gaspé district," the first region examined, "little was known in 1843 beyond the coast-line; of the geology, practically nothing. Settlements were few, confined almost exclusively to the coast, and made up chiefly of fishermen. There were no roads through the interior, most of which was (and, indeed, still is) a wilderness, inhabited by bears and other wild beasts, or at best only penetrated, in certain seasons of the year, by a few Indians or lumbermen. The courses of most of the streams were unknown, and the precipitous mountain-passes untraversed. Such was the country whose geology Logan was now to investigate." Other inconveniences were coarse food and hard beds, camping in wigwams that kept out only part of the rains, frequent bruises from working among rocks, bites of insects, and the vulgar inquisitiveness of persons who could only conceive him to be a searcher for the precious metals or a lunatic. The following words of Mr. Murray, his geological assistant in Canada, descriptive of Logan's habit while in Wales, apply also to his longer labors in Canada: "Even at that early period, when every comfort of life was easily accessible, I observed his utter indifference to self-indulgence of any kind, or even such ordinary comforts as most people would be inclined to call indispensable necessities. After an early and very simple

breakfast, he would buckle on his instruments, grasp his hammer, and, with map in hand, march off to the field, in which he would toil on without cessation, without thinking for a moment of food or rest, until the shades of evening gave warning that it was time to retrace his steps toward home, or to seek some temporary dwelling." Such a day Logan would supplement, in Canada, by writing up the day's notes and his journal in a wigwam, often working past midnight.

The winters, which interrupted field-work, by no means brought idleness to him. There were the geological specimens to sort, label, and arrange in cabinets, reports to write up, expense accounts to prepare, and maps to construct, work on which the smallness of the appropriations allowed only scanty assistance.

In 1850 the Provincial Government decided to send a collection of Canadian economic minerals to the London World's Fair of the next year, and Logan was sent in charge of the exhibit. During this visit to England, Logan was present at a meeting of the British Association, and read a paper entitled "On the Age of the Copper-bearing Rocks of Lakes Superior and Huron, and Various Facts relating to the Physical Structure of Canada." He was elected a Fellow of the Royal Society at this time, being "the first native Canadian elected for work done in Canada." He also served as one of the eight jurors in the Mineralogical and Metallurgical Department of the Exhibition. Logan was also one of the two Special Commissioners in charge of the Canadian exhibit at the French Exhibition of 1855, and here as before he worked almost incessantly for many weeks arranging his section. He was not suffered to go unrewarded, for he received the Grand Gold Medal of Honor for his map and minerals, and was presented by the Emperor with the cross of the Legion of Honor. Other honors were now bestowed upon him in rapid succession. On the 29th of the following January he was knighted by the Queen at Windsor, for services rendered at the two exhibitions, and about the same time he was informed that the Palladium or Wollaston medal—"the greatest honor the Geological Society has to bestow"—would be publicly presented to him at the annual meeting of the society. Other honors and testimonials were tendered to him on his return to Canada.

Sir William at once resumed his former labors and continued them until he was interrupted by another exhibition—that of 1862 in London. He was sent as Chief Commissioner from Canada, and was again made a juror; but the hurry in which his work had to be done, and the invitations that were showered upon him, were not to his taste, and he sought an early opportunity to return to Canada. In the next year his "Geology of Canada" was published, of which work Professor Harrington writes: "It was more than eight years since its preparation had been ordered by Government, and many thought that its publication ought not to have been so long deferred. But neither the

country nor science lost anything by the delay; for the volume was not a mere summary of the earlier reports of the survey, but a new book containing all the earliest facts concerning the geology of the country. The work is too well known to require any comment here, but it may be stated that, although published nearly twenty years ago, it remains to-day the most valuable book of reference on the geology and mineralogy of the Provinces of Ontario and Quebec." In 1864 Sir William went to England to attend to the final work on the large geological map of Canada and the neighboring States, which was to accompany his "Geology." He attended the meeting of the British Association in September, and read papers on the fossils of the Laurentian rocks—*Eozoön Canadense*—which he and Drs. Hunt and Dawson had been mainly instrumental in bringing to notice. The significance of this discovery may be indicated by a sentence from the presidential address of Sir Charles Lyell for that year: "We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created."

At the Paris Exhibition of 1867, the geology of Canada was well represented under charge of Dr. Hunt. Sir William was promoted by the Emperor of France to an officer of the Legion of Honor, and a few months later the Council of the Royal Society awarded him one of the two Royal Gold Medals of the year for his "geological researches in Canada, and the construction of a geological map of that colony."

In 1869 Sir William, finding that his private work demanded all his somewhat declining energies—he was then seventy-one years old—resigned his position as director of the Canadian survey. He continued geological work, however, in Canada and adjoining parts of New England for several seasons, his last investigations being made in the Eastern Townships in the summer of 1874. In August he sailed for England, intending to return in the spring, but during the winter, while he was staying in Wales with a sister, the disease which had been gradually coming upon him grew rapidly more serious; he rallied somewhat in the spring, but never got really strong again, and died June 22, 1875.

"Those who had the good fortune to know Sir William Logan" (we quote from Professor Harrington's biography) "will remember him not merely as an enthusiastic geologist, but as a frank, true, and genial friend. Many a fellow-creature was cheered by his cheerfulness, helped by his kindly advice and sympathy, or in the more substantial way which ample private means rendered possible. In many respects his was a solitary life. Unlike his great contemporaries, Murchison and Lyell, he never enjoyed the sympathy and assistance of a wife. His over-active mind, no doubt, needed to be drawn from the geologi-

cal grooves in which it ran, and if on returning to Rockfield, after the worries of the office or the hardships of the forest, there had been more of the attractions of home, his life would have been happier and possibly even longer than it was. . . . Earnestness and singleness of purpose were among the most marked features of Sir William's character. From the time that he began the geological survey until the day of his death, the great aim which was perpetually before him was to thoroughly elucidate the geology of Canada, and to render the knowledge acquired subservient to the practical purposes of life and to the advancement of his native country. He was continually beset with requests to examine and report upon mines in various parts of the country, but invariably refused unless he felt that the information derived would be of advantage to the public. Nor would he, on any such occasion, accept of remuneration for his services. Any *bona fide* attempt on the part of individuals or companies to develop the mineral resources of the country was sure of his encouragement and advice if asked for; but the impostors who tried to palm off "salted" mines or impossible geological discoveries upon the unsuspecting public he despised, and always took an intense pleasure in exposing their schemes. . . .

"Sir William had little capacity for literary work, and, although he usually expressed himself with precision and force, his style was lacking in ease and gracefulness. Fine writing, however, was not his object, but rather to describe in simple language the results of observations in the field. . . . As he advanced in life, he found the work of composition more and more arduous. For some years before his death he contributed nothing to the literature of science, and even ordinary correspondence became increasingly distasteful to him."

Logan was a member of more than a dozen learned societies; his degree of LL. D. was bestowed by McGill University in 1856, and that of D. C. L. by the University of Lennoxville the year before. Over twenty medals, and various other testimonials, show the esteem in which his work was held. His most important writings have already been mentioned; some other papers were, "On the Footprints occurring in the Potsdam Sandstone of Canada," "On the Division of the Azoic Rocks of Canada into Huronian and Laurentian," "Considerations relating to the Quebec Group and the Upper Copper-bearing Rocks of Lake Superior," etc.

CORRESPONDENCE.

A CRITICISM AND A REPLY.

Messrs. Editors:

IN the realm of popular science a clear, piquant style is good, to unfold and adhere strictly to truth is better; but a union of these is the best of all. No one who has read Dr. Oswald's series of papers on health and disease in this "Monthly" can deny him the first attribute; but he must be superficial, indeed, who will allow him the second. I do not mean to say that all or even the larger part of his inculcations are false, but only that some of them are so glaringly contrary to fact that the special and cultivated observer can only tolerate the reading of them by the vigorous excellence of their surroundings.

It is not my intention to point out all the errors that have appeared in his long series of papers. I shall only refer to a few in his last article (July), entitled "The Remedies of Nature" for dyspepsia—a misnomer, by-the-way, as the remedies recommended are not Nature's, but Dr. Oswald's; as, for instance, "sleeping in a *cross-draught*," whatever this may mean, as a bulwark against dyspepsia.

On page 307 the doctor asserts that dyspepsia is not an hereditary complaint. If it is not, then there is no such thing. When consumption, cancer, and insanity, are spoken of as hereditary, the meaning is not that either of these diseases exists *per se* from the moment of conception, only that the tendency to them does. But the tendency to dyspepsia in some families is even more literally hereditary than the diseases named, for every careful and wide-observing physician knows that the offspring of some parents, almost from the moment of birth, manifests a facility for indigestion from the most trifling indiscretions. Observant mothers know that their own or neighbors' children, all of like habits and conditions of life, are strikingly unequal in digestive strength. Some of them can not eat this or that without severe suffering, others can eat of every unwholesome viand, and laugh at warnings; and this, not only in childhood, but more or less all through life. The difference is wholly inexplicable, except on the principle of heredity.

Our bright and spicy writer tells the dyspeptic "under no circumstances to resort to drug-exorcism." Only a person of superficial knowledge, of strong physique, and bigoted withal, who judges all others by his own personal equation, could discourse thus. Men and women will eat and drink, either with or without knowledge, what they ought not; as a consequence, the stomach rebels, and intense suffering ensues. Only a short time since I saw a woman who had been writhing every few minutes with terrible gastric cramps for ten hours. Clearly it was an attack of acute dyspepsia. To the suggestion of an emetic she answered that a vomit nearly killed her, and, besides, nothing could be on her stomach, as nothing had been eaten all day. But another paroxysm of cramp led her to exclaim, "Well, anything for relief!" In a few minutes she threw up nearly a gallon of fermenting food, that filled her chamber with the fumes of a fetid sourness worse than that of an August swill-tub. Half an hour after, she fell into a calm sleep. If humans will eat and drink what they ought not—eating, not for need but for pleasure, not as a means but as an end—the physician's duty is clearly to relieve suffering by the removal of its immediate cause, as by an emetic or cathartic. Of course, the homœopathic dogma (all dogmas in science are heretical) is to do nothing of the kind; to wait on Nature, and she will remove all the impurities of the alimentary canal herself. It is a source of surprise that these idealists, if they wish to be thought consistent, should ever use any soap and water to remove the impurities from their skins; they should wait on Nature, and she will scale the dirt off herself. Certes, skin-foulness is as nothing compared to bowel-filth, and a cathartic soap often lifts, as no skin-cleaning does, an oppressive incubus from the presence of organic decomposing matter in the intestines, which is death itself when a little of it finds its way into the blood. A grain of aloin thrown into the blood-current hypodermically will simply act as a purge; a grain of decaying animal matter similarly used will kill just as surely as a bullet through the lungs. Homœopaths magnify drug-poisoning five hundred diameters; but when they look for the poisons of diseases they reverse the microscope, seeing nothing at all.

Our lively doctor argues for fewer meals per day—even for the single-meal system—as the remedy for dyspepsia (page 312). Vaporific theorizing, without a scintilla of verification, is scarcely worthy of notice. After thirty years' reading and close practical observations, I have yet to learn of a man, not a sensational crank, who seriously proposed, much less gave instances in which it had been successfully employed, as a remedy for dyspepsia. Tens of thousands of practical scientists have tried and found

just the opposite plan successful—to wit, eat only and as often as hunger prompts, but always abstemiously, on the principle that a weak stomach, like a weak body, can not manage one big load so readily as several small ones. Enough to nourish the body twenty-four hours is a pretty big meal. For the weak, divide the task to be accomplished, if a break-down by a supreme effort is undesirable.

The recommendation to the dyspeptic to adopt the habits of savages and ophidians is, to say the least, a display of supercilious conceit over Dame Nature, whom our writer professes so much to admire, when she so benignantly takes charge of the matter, saying, when athirst, water is needed; when we hunger, that food is. If men and women would only follow her monitions in this matter, and cease to drink when thirst is satisfied, cease to eat when hunger is, yielding not to the seductions of a *menu*—each course made more and more appetizing, so as to tempt a satiated appetite to commit the grossest excesses—half the dyspepsia in the land would disappear.

J. R. BLACK.

NEWARK, OHIO, *June* 25, 1883.

DR. OSWALD'S REPLY.

Messrs. Editors:

THE friends of science owe you a vote of thanks for the unabridged publication of the foregoing epistle. Whether the orthodox school of therapeutics has much reason to thank Dr. Black for undertaking its defense, your readers may be inclined to doubt, but his letter is an encouraging sign of the times. As an attempt to suppress the propaganda of unorthodox tenets, it marks the ascendency of the third or controversial sophistry phase of argumentation. The primitive method was rude, though it had sometimes the advantage of practical conclusiveness. In the winter of 1682 the Spanish missionaries on the Rio Zelades in Yucatan reported a revival of irreligious tendencies among the aborigines of the district. Three weeks after, Colonel Perez Garcia invaded the diocese with a brigade of trained mastiffs. The natives had betrayed symptoms of skepticism, but the arrival of the four-legged dogmatists at once solved all doubts. The dangers of unbelief could no longer be questioned. The local Ingersolls were treed by hundreds, and the fervor of the revival almost surpassed the hopes of the propagandists. The scoffers were overtaken by the Nemesis of Faith, fugitives were recaptured and dragged back, breechless and howling; in short, to use an expression of the Rev. Joseph Cook's, there was "not a fig-leaf left to hide the shame of historical skepticism."

In the course of time the Garcia system was superseded by the personal-abuse method: "Professor X—— pretends to question the fact that Philip II possessed a duplicate skeleton of St. Laurentius. The professor's arguments are specious and might be worth refuting, if it were not well known that three years ago he married the daughter of a horse-farrier so notoriously addicted to the use of alcoholic beverages that at the present moment he is probably wallowing behind his stable in a state of scandalous intoxication." That settled it.

The misrepresentation plea, I hold, is a decided improvement upon the aforesaid methods. Like boomerangs, sophisms are crooked weapons, but they are occasionally apt to recoil in an unexpected manner, and may thus serve the cause of truth in spite of their constructor. Dr. J. R. Black betrays an intermittent tendency to relapse into the secondary system, but, on the whole, contents himself with the attempt to refute my tenets by misconstruing my arguments. He charges me with an habitual neglect of the duty "to unfold and adhere strictly to truth," and supports his indictment by the following specifications: He claims that, in repudiating the alleged hereditary transmission of dyspepsia, I disregard an indisputable fact, because "every careful and wide-observing physician" knows that in the children of some families a tendency to indigestion manifests itself almost from the moment of birth. Does our careful and wide-observing correspondent propose to deny that from the moment of birth millions of infants are both overfed and drug-poisoned? That a predisposition to various diseases may exist in the form of a latent tendency, I have often admitted; the point at issue is, whether such tendencies ever manifest themselves in spite of an hygienic regimen, and whether dietetic abuses, aggravated by emetics, cathartics, and paregoric, ever fail to accelerate their development. The monstrous death-rate of children in the institutes managed on the plan of Dr. Black's orthodox colleagues can no longer be explained by such convenient excuses as the fatality of an inherited disposition.

My predilection for non-medicinal remedies Dr. Black attributes to the strength of my physical and the debility of my mental constitution, and betrays an uncharitable disposition to aggravate the sorrows of my predicament by grudging me the use of soap and water. The voluntary renunciation of that cosmetic, he intimates, would prove at least my practical consistency. It is a source of surprise that our careful and wide-observing scientist has not yet learned to avoid the vulgar fallacy of confounding the artificial with the unnatural. Between the legitimate methods of assisting, imitating, and developing the tendencies of Nature and the audacious attempt to counteract her operations,

there is all the *toto cælo* difference of a duty and a mischievous presumption. Can an opponent of venesection not use a lancet to scrape the ink off his finger-nails, without incurring the reproach of inconsistency? Nature never fails to protest emphatically against the nauseous nostrums which the drug-monger employs under the pretext of relieving her embarrassments. Does she ever protest against soap and water? Does sapolio irritate the human skin? If not, a consistent anti-naturalist should cleanse his hands by means of a blister. In the opinion of our medical hierophant it will probably aggravate the iniquity of the "idealists" that the practical embodiment of their theories has proved a decided success. In the United States alone there are forty-six well-patronized hygienic sanitaria that restrict the use of drugs almost, or wholly, to the exceptional cases named on page 729 of "The Popular Science Monthly" for October, 1881. Drs. Schrodt, Maurice Nagy, James Knight, L. B. Coles, Abbott, Coleman, and the disciples of Graham, Alcott, and Isaac Jennings, have not recanted their tenets, and count their followers by tens of thousands. Unto all such Dr. J. R. Black ascribes superficialness, bigotry, and a sound physical constitution. The latter charge, I apprehend, can not be retaliated upon his own converts.

Hahnemann's heresies our critical observer imputes to an optical perversity. If his diagnostic spectacles enable him so distinctly to discern the "poison of disease," he ought to know better than to aggravate it by an additional poison. And if the doctor believes that the tenuous prescriptions of the homœopaths can not be considered as medicines, their success proves the very point I am contending for, namely, that in an infinite plurality of cases diseases can be better cured without any drugs at all.

Such "vaporific theorizing" as my plea for longer pauses between meals, Dr. J. R. Black thinks "scarcely worthy of notice." If the history of dietetics were not so far beneath the notice of a duly-ordained drug-dispenser, the doctor would perhaps know that many millions of the races who approach most nearly to the ideal of perfect physical and intellectual development adhered for sixty generations to the one-meal system, and that the plan of reducing the number of daily meals has been tested and urgently recommended by Drs. Haller,* Graham, Joel Ross, Dawson,† Dio Lewis,‡ C. E. Page,* and T. L. Nichols,† of London, as well as by thousands who have tried its efficacy for the cure of obstinate enteric disorders. All these men Dr. J. R. Black denounces as sensational cranks, savages, and ophidians, and accuses me of an inconsistent and "supercilious conceit over Dame Nature," for disregarding her "monitions in this matter." In his eagerness to achieve the glory of a *defensor fidei*, Dr. J. R. Black does not shrink from such trifles as logical solecisms. I have certainly never missed an opportunity to urge the importance of consulting the promptings of our natural instincts; but does the doctor propose to apply that rule to the cravings of a morbid appetency? Or have his "thirty years' reading and close practical observation" not yet taught him that the chronic hunger of a dyspeptic is as abnormal as the poison-thirst of a confirmed drunkard?

"For the weak divide the task to be accomplished," says he—as if the assimilation of food were a mechanical operation. Dr. Black's decalogue needs a revision if he does not know that digestion is a chemical process, and can be better accomplished in a longer time (by prolonging the pause between meals) than by a division of labor. And what has the illiteracy of a South-Sea Islander to do with the competence of his hygienic instincts? Is the doctor's fund of valid arguments so scant that he has to resort to the expedient of an irrelevant charge? With the same logic the savage might refuse to accept the moral tenets of a short-sighted pale-face.

And Dr. Black's depreciation of the eupeptic ophidian is hardly less injudicious. No consistent follower of his school should allude with disrespect to the trade-mark of his craft—the Æsculapian pet that first suggested the art of utilizing our fellow-creatures by poisoning them.

FELIX L. OSWALD.

A HOMŒOPATHIC CORRECTION.

Messrs. Editors:

AN article in your June issue, which attempts to deal with the question of quackery, refers at some length to the system of medical practice known by the name of homœopathy. I do not write for the purpose of exposing the fallacies or correcting all the misconceptions of the author; for I am not certain how far you would be willing

* "Ein Catholicon, eine überall gültige Regel in allen Krankheiten, ist die Zahl der täglichen Mahlzeiten zu reduciren."

† "It may be said, if we deprive the already wasted body of nourishment for any length of time, will we not run the risk of losing our little patient? To these questions I reply: *Starve the stomach! Give it rest!*"

‡ "I have tested the sufficiency of eating once in twenty-four hours, and have done work enough to put a younger man to his trumps if he had to do it. . . . I keep up my strength and have held in check my constitutional tendencies so that I have reached old age."

* "No person ever tried the plan and found reasons for abandoning it, except from considerations utterly remote from health."

† "The one-meal-a-day system will largely increase any person's working capacity."

to convert your monthly into a medium for the settlement of doctors' differences. I only wish to correct a misstatement of facts concerning the condition of practitioners of the homœopathic school in the Province of Ontario; in regard to which, the position I have held on the Board of Examiners and the Medical Council may justify me in speaking with authority. The misstatement is to the effect that "in Ontario, up to ten years ago, homœopaths were yearly registered by scores; since then they have to pass through the same courses and examinations as the regular students, in all but therapeutics and pharmacy. The consequence is, that in ten years there have only been two or three applications for examinations as homœopaths. Homœopathy is now dying a natural death."

1. Up to ten years ago, homœopaths were not "registered" (licensed, he means, for there was then no registering) by scores. Half a score a year was considered a large number. The old law required a longer course of study from homœopathic than allopathic students; and much longer than was necessary for graduation in a United States college. As a consequence, fully five sixths of our students settled across the line.

2. In the ten years following, under the new law, instead of only two or three homœopaths licensed for the whole period, there have been applicants every year—some as homœopaths, while others have passed the allopathic examinations. And, though the number of applicants may be less now than formerly, the diminution applies to students of all schools—the result of our extended course of study and rigid examinations. The proportion of allopathic and homœopathic applicants remains about the same.

3. The way "homœopathy is dying" in Ontario is illustrated by the fact that the President of the Medical Council, the *ex-officio* head of the medical profession, is this year an avowed homœopathist, and a graduate of a homœopathic college. And he has been elected to that position by a two-thirds vote of a body in which allopathic physicians have a majority of five to one.

As nearly all the statements regarding homœopathy in the article referred to have as much foundation in fact as those I have taken the liberty of correcting, it is evident that your contributor's assertions will need more than a single grain of salt to render them acceptable. Misstatements of facts are always made either in ignorance or in malice. Your contributor probably knows better than I the cause of those that have called forth my corrections.

CL. T. CAMPBELL.

LONDON, ONTARIO, *June* 25, 1883.

"OUR MARRIAGE AND DIVORCE LAWS."

Messrs. Editors:

GORDON A. STEWART, writing on "Our Marriage and Divorce Laws" in the June number of the "Monthly," in speaking of the causes for which divorces may be granted in different States, uses this language: . . . "In Connecticut, Indiana, Illinois, North Carolina, and Maine, there is any cause that a discontented and dishonest party may allege, or that a judge in his discretion, influenced by sympathy or corrupt motives, may approve."

As applied to Indiana this statement is wholly without foundation. In this State the causes for divorce are clearly defined by statute. No one is entitled to a divorce who can not show the existence of some one or more of the statutory grounds.

No discretion is vested in the judge, further than that of saying when the evidence is sufficient to prove the existence of the cause for which a divorce is asked. At one time Indiana had such a statute, but it was repealed many years ago. Mr. Stewart having thus (inadvertently, I presume) libeled our State, should make the "*amende honorable*" through the columns of the "Monthly," and will doubtless take pleasure in doing so when his attention is called to the matter.

R. W. MCBRIDE.

WATERLOO, INDIANA, *June* 20, 1883.

EDITOR'S TABLE.

THE DEAD-LANGUAGE SUPERSTITION.

THE celebrated defense of classical studies in college education delivered at the University of St. Andrew's, some fifteen years ago, by John Stuart Mill, produced a very powerful effect upon the public mind, and was thought by many to end all discussion upon the question. Mr. Mill had a great reputation, which was at that time at its full height. He was a man of extensive erudition, and fine mental accomplishments, and was, moreover, a radical reformer, and ranked high as a representative of modern ideas. Not being himself a university man, and standing as a leading liberal, it was naturally supposed that he would take the modern

side in the great educational controversy between the rival claims of the old classics and the new science. But, to the surprise of nearly everybody, Mr. Mill came out the ultra-defender of the dead languages as against the living languages and modern studies, and went to the utmost extreme in his vindication of the traditional supremacy of the ancient classics.

It was recognized at the time that this was an anomalous and not fully explicable proceeding. We have it on good authority that, when Mr. Mill was inquired of as to his unexpected course, he excused it by saying that the scientific tendencies of the times are becoming too strong, and require to be checked —an explanation that still needed to be explained. Had Mr. Mill been himself less of a classicist and more of a scientist, less a devotee of the humanities and more a student of nature, he would have seen that these modern scientific tendencies are the inevitable results of a great evolutionary process of the human mind—a movement in the direction of higher knowledge—and no more to be withstood than the unfolding transformations of the natural world or the progress of human society.

But it was at that time too early to get the full explanation of Mr. Mill's position so as to understand his overwhelming bias in favor of the ascendency of dead languages and ancient literature in the collegiate preparation of young men. Not until the appearance of his "Autobiography" and the publication of the "Life of James Mill," his father, by Mr. Bain, was the secret of the situation fully revealed. It was of course known that James Mill was a man of great intellectual capacity and force, and it was believed that the son inherited from him these qualities in an eminent degree. But James Mill was a man who held very positive views on the subject of education, believed profoundly in its omnipotence, and resolved to show, in the case of his son, what it is capable of doing. He was, besides, an infatuated classicist, and a passionate admirer of the Greek language. And when we further remember that he was an iron-willed tyrant, and would not trust his son to other teachers, but himself became his tutor from babyhood to manhood, we can begin to appreciate the kind of influence to which young Mill was subjected. Crammed with classics in his earliest childhood, thinking in Greek at seven years of age, and overloaded with intellectual acquisitions of the highest order by his father's fanatical pedantry, the young fellow's faculties were kept upon the strain during the period of his bodily growth, until he was brought to the verge of insanity before he was yet of age. His strong mental constitution did not give way, but it was so warped and subjugated by his one-sided discipline that he was the last man living from whom to expect an unprejudiced judgment on the subject of mental cultivation.

When, therefore, Mr. Mill came to lay down the broad requirements of higher education, in his St. Andrew's discourse, he reasoned from his own remarkable experience, and insisted upon the inexorable predominance of the studies of which he had himself been made the victim. He went in for the ancient languages and the ancient literature as supreme, and relegated to a secondary place all the great results of modern thought. He ruled out from his curriculum the studies of history, of geography, of modern languages, and modern literature. Admitting the importance of science, he nevertheless assigned it a subordinate place in his scheme of education. Taking little account in his imposing plan either of the limitations of the human mind, the varying grades of human capacity, or the actual circumstances of human beings, he drew a scheme of culture that had but small application to the practical necessities of human life. His

ideal university was, therefore, but a cloud-land romance. Its course of studies, patterned on his own comprehensive erudition, was little else than an elaborate recipe for making John Stuart Mills. He forgot that, whatever may be a man's native intellectual power, universality must be the eternal equivalent of superficiality, and he was himself a striking illustration of this forgotten truth. His acquaintance with science was so superficial that he was compelled to seek the aid of others in getting even the scientific illustrations needful for the exposition of his great work on logic. We do not go too far in saying that he lost his hold upon the age as a philosophic thinker by his want of command of the great scientific results of modern inquiry. He had been so long and so thoroughly steeped in the spirit of antiquity that he was disqualified for appreciating the grand import of modern ideas. He was a powerful student of human affairs, but from the antiquated point of view. He was in the Golden-Age, Paradise-Lost dispensation of thought in which the notions of the early perfection of mankind and the superiority of the ancients were contrasted with the degeneracy of the moderns, and so completely was his intellect possessed and perverted by this view, that he was disabled from appreciating the immense and epoch-making influence of the modern doctrine of evolution.

Yet palpable as were its exaggerations, and preposterous as were its estimates of the relative importance of different kinds of knowledge, the St. Andrew's address had an extensive and a very injurious influence. It was a godsend for the declining classical cause, for, although Mr. Mill condemned unsparingly the existing teaching of classics, its partisans cared nothing for that, so long as he conceded the predominance of classical claims. So his authority became a new bulwark for the defense of established abuses. It strengthened the hands of educational obstructives, and the specious arguments offered for the exaltation of ancient learning re-enforced all its arrogant and exclusive pretensions. The commendations of science went for nothing, as the magnitude of the classical claims left no room for them. Mr. Mill labored to extend the already excessive influence of dead-language studies in the colleges, and the power of his name was thus effectually arrayed against the rising demands of modern knowledge.

We have recalled this memorable discourse of Mr. Mill at the present time, because it is a landmark in the recent history of the controversy, and because since its publication the subject of dead languages in the colleges has had no such vigorous shake-up as has been given to it by Mr. Charles Francis Adams, Jr., in his telling address delivered before the Harvard chapter of the fraternity of the Phi Beta Kappa on June 28th. Mr. Adams is, of course, on the side of modern studies as against the classics. Into the argument as presented by Mr. Mill he does not enter, nor does he deny the transcendent benefits which some allege they have derived from the study of dead languages. But, not concerned with its ideals, he deals with the current classical education as a familiar fact, and tests it by its actual fruits. His point of view is that of common, well-to-do people, who demand the advantages of a higher education, but whose time of study is limited, and who must pass from the college to the labors and struggles of every-day life. Appealing to experience, to hard practical results, he finds himself compelled to condemn the system as a failure, a defeat of the true and highest purposes of education, an outrageous wrong to youth, and in its stubborn persistence against all the dictates of common sense a scandal to the intelligence of the age. Mr. Adams, moreover, proves his case. We

venture to assert that no candid person can read this production, in connection with that of Mill, without recognizing that, to all the intents and purposes of the discussion, the American student of railroads has given a crushing answer to the English philosopher.

We are first of all glad to recognize that Mr. Adams has dealt with the subject with the freedom of entire fearlessness, and has set a much-needed example. He has not minced matters, but has boldly and bluntly said what a great many others think but hesitate to express. There is a good deal more intense conviction upon this matter than gets publicly uttered. Most men who have invested in classical education, and find that they have been sold, are anything but eager to acknowledge it. Having been cheated, they prefer to keep quiet about it. But Mr. Adams told the authorities of Harvard College to their faces that he had been victimized by their policy, and was there to arraign it on that very intelligible ground. In most explicit terms he characterized the worthlessness of the fundamental studies of that school, and which are the fundamental studies of most other colleges. But little further progress is to be made in the way of plain speaking when the staple of college study is openly denounced in the halls consecrated to it, and in the congregated presence of all parties to it, not only as a superstition, but as a superstition of the lowest and grossest sort. Greek and Latin, as pursued in our higher institutions, he pronounced to be nothing less or other than a "college fetich." It is among the native African negroes that fetichism is in most eminent vogue. A fetich is some object, no matter what—a tree, a mountain, a beast, a bit of wood, a lion's tail, an old bone—which the besotted native adores as possessed of religious potency, and to which he ascribes marvelous or magical power. A "college fetich" is, therefore, a study which is looked upon with a kind of stupid veneration, as capable of exerting mysterious and wonderful influences upon the minds of those devoted to it. The dead-language fêtich is a matter of blind adoration. It is of but little use to argue against it—of but little use to reason with the fetichistic state of mind—for the peculiarity of any inveterate superstition is that it may be riddled with logic through and through, and its absurdity demonstrated over and over, without impairing in the slightest degree the mystical faith in its efficacy. Mr. Adams, therefore, confined himself mainly to an exposure of the results of the dead-language superstition, as he knew it and had suffered by it, in the college which gave him his education. His point of view was thus indicated: "To-day, whether I want to or not, I must speak from individual experience. Indeed, I have no other ground on which to stand. I am not a scholar; I am not an educator; I am not a philosopher; but I submit that, in educational matters, individual practical experience is entitled to some weight. Not one man in ten thousand can contribute anything to this discussion in the way of more profound views or deeper insight. Yet any concrete actual experience, if it be only simply and directly told, may prove a contribution of value, and that contribution we all can bring. An average college graduate, I am here to subject the college theories to the practical test of an experience in the tussle of life." Mr. Adams then describes how he entered the Latin School and learned two grammars by heart, and spent five years in mastering "the other rudiments of what we are pleased to call a liberal education," and then went through Harvard College, devoting himself industriously to all the regulation studies of which Latin and Greek were fundamental. Entering upon active life with his college preparation, he took hold of one of the large problems which has

forced itself upon the thought of the present age with the following result: "I made for myself what might perhaps be called a specialty in connection with the development of the railroad system. I do not hesitate to say that I have been incapacitated from properly developing my specialty by the sins of omission and commission incident to my college training. The mischief is done, and, so far as I am concerned, is irreparable. I am only one more sacrifice to the fetich. But I do not propose to be a silent sacrifice. I am here to-day to put the responsibility for my failure—so far as I have failed—at the door of my preparatory and college education."

Mr. Adams charges that this failure is very far from being a thing of imagination or sentiment; but, on the contrary, it has been not only matter-of-fact and real, but to the last degree humiliating. He convicts his college of having refused to furnish him with that modern knowledge which is indispensable to effective work in modern life; of withholding from him the knowledge of those living languages which open communication with the world of contemporary thought; of wasting his youthful years upon dead languages which were never learned; of substituting a lax superficiality for thoroughness of attainment; of forcing its vicious system back upon the preparatory schools; and of adhering with superstitious tenacity to an educational policy fitted only to turn out incompetent smatterers, not half taught in subjects of very small importance. We quote some pointed passages of his indictment:

> Now as respects the college preparation we received to fit us to take part in this world's debate. As one goes on in life, especially in modern life, a few conclusions are hammered into us by the hard logic of facts. Among those conclusions I think I may, without much fear of contradiction, enumerate such practical, common-sense, and commonplace precepts as that superficiality is dangerous, as well as contemptible, in that it is apt to invite defeat; or, again, that what is worth doing at all is worth doing well; or, third, that when one is given work to do, it is well to prepare one's self for that specific work, and not to occupy one's time in acquiring information, no matter how innocent or elegant, or generally useful, which has no probable bearing on that work; or, finally—and this I regard as the greatest of all practical precepts—that every man should in life master some one thing, be it great or be it small, so that thereon he may be the highest living authority; that one thing he should know thoroughly.
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> How did Harvard College prepare me, and my ninety-two classmates of the year 1856, for our work in a life in which we have had these homely precepts brought close to us? In answering the question it is not altogether easy to preserve one's gravity. The college fitted us for this active, bustling, hard-hitting, many-tongued world, caring nothing for authority and little for the past, but full of its living thought and living issues, in dealing with which there was no man who did not stand in pressing and constant need of every possible preparation as respects knowledge and exactitude and thoroughness—the poor old college prepared us to play our parts in this world by compelling us, directly and indirectly, to devote the best part of our school lives to acquiring a confessedly superficial knowledge of two dead languages.
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> In regard to the theory of what we call a liberal education, there is, as I understand it, not much room for difference of opinion. There are certain fundamental requirements, without a thorough mastery of which no one can pursue a specialty to advantage. Upon these common fundamentals are grafted the specialties—the students' electives, as we call them. The man is simply mad who in these days takes all knowledge for his province. He who professes to do so can only mean that he proposes, in so far as in him lies, to reduce superficiality to a science.
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> Such is the theory. Now, what is the practice? Thirty years ago, as for three centuries before, Greek and Latin were the fundamentals. The grammatical study of two dead languages was the basis of all liberal education. It is still its basis. But, following the theory out, I think all will admit that, as respects the fundamentals, the college training should be compulsory and severe. It should extend through the whole course. No one ought to become a Bachelor of Arts until, upon these fundamentals, he had passed an examination, the scope and thoroughness of

which should set at defiance what is perfectly well defined as the science of cramming. Could the graduates of my time have passed such an examination in Latin and Greek? If they could have done that, I should now see a reason in the course pursued with us. When we were graduated, we should have acquired a training, such as it was; it would have amounted to something; and, having a bearing on the future, it would have been of use in it. But it never was for a moment assumed that we could have passed any such examination. In justice to all, I must admit that no self-deception was indulged in on this point. Not only was the knowledge of our theoretical fundamentals to the last degree superficial, but nothing better was expected. The requirements spoke for themselves; and the subsequent examinations never could have deceived any one who had a proper conception of what real knowledge was.

But in pursuing Greek and Latin we had ignored our mother-tongue. We were no more competent to pass a really searching examination in English literature and English composition than in the languages and literature of Greece and Rome. We were college graduates; and yet how many of us could follow out a line of sustained, close thought, expressing ourselves in clear, concise terms? The faculty of doing this should result from a mastery of well-selected fundamentals. The difficulty was that the fundamentals were not well selected, and that they had never been mastered. They had become a tradition. They were studied no longer as a means, but as an end—the end being to get into college. Accordingly, thirty years ago there was no real living basis of a Harvard education. Honest, solid foundations were not laid. The superstructure, such as it was, rested upon an empty formula.

The reason of all this I could not understand then, though it is clear enough to me now. I take it to be simply this: The classic tongues were far more remote from our world than they had been from the world our fathers lived in. They are much more remote from the world of to-day than they were from the world of thirty years ago. The human mind, outside of the cloisters, is occupied with other and more pressing things. Especially is it occupied with a class of thoughts—scientific thoughts—which do not find their nutriment in the remote past. They are not in sympathy with it. Accordingly, the world turns more and more from the classics to those other and living sources in which alone it finds what it seeks. Students come to college from the hearthstones of the modern world. They have been brought up in the new atmosphere. They are consequently more and more disposed to regard the dead languages as a mere requirement to college admission. This reacts upon the institution. The college does not change—there is no conservatism I have ever met, so hard, so unreasoning, so impenetrable, as the conservatism of professional educators about their methods—the college does not change; it only accepts the situation. The routine goes on, but superficiality is accepted as of course; and so thirty years ago, as now, a surface acquaintance with two dead languages was the chief requirement for admission to Harvard; and, to acquiring it, years of school life were devoted.

Nor in my time did the mischief end here. On the contrary, it began here. As a slipshod method of training was accepted in those studies to which the greatest prominence was given, the same method was accepted in other studies. The whole standard was lowered. Thirty years ago—I say it after a careful search through my memory—thoroughness of training in any real-life sense of the term was unknown in those branches of college education with which I came in contact. Everything was taught as Latin and Greek were taught. Even now, I do not see how I could have got solid, exhaustive teaching in the class-room, even if I had known enough to want it. A limp superficiality was all-pervasive. To the best of my recollection the idea of hard thoroughness was not there. . . .

Many of you are scientific men; others are literary men; some are professional men. I believe, from your own personal experience, you will bear me out when I say that, with a single exception, there is no modern scientific study which can be thoroughly pursued in any one living language, even with the assistance of all the dead languages that ever were spoken. The modern languages are thus the avenues to modern life and living thought. Under these circumstances, what was the position of the college toward them thirty years ago? What is its position to-day? It intervened, and practically said then that its graduates should not acquire those languages at that period when only they could be acquired perfectly and with ease. It occupies the same position still. It did and does this none the less effectually because indirectly. The thing came about, as it still comes about, in this way: The college fixes the requirements for admission to its course. The schools and the academies adapt themselves to those requirements. The business

of those preparatory schools is to get the boys through their examinations, not as a means, but as an end. They are therefore all organized on one plan. To that plan there is no exception; nor practically can there be any exception. The requirements for admission are such that the labor of preparation occupies fully the boy's study-hours. He is not overworked, perhaps, but when his tasks are done he has no more leisure than is good for play; and you can not take a healthy boy the moment he leaves school and set him down before tutors in German and French. If you do, he will soon cease to be a healthy boy; and he will not learn German or French. Over-education is a crime against youth. But Harvard College says, "We require such and such things for admission to our course." First and most emphasized among them are Latin and Greek. The academies accordingly teach Latin and Greek; and they teach it in the way to secure admission to the college. Hence, because of this action of the college, the schools do not exist in this country in which my children can learn what my experience tells me it is all-essential they should know. They can not both be fitted for college and taught the modern languages. And, when I say "taught the modern languages," I mean taught them in the world's sense of the word, and not in the college sense of it, as practiced both in my time and now. And, here let me not be misunderstood, and confronted with examination papers. I am talking of really knowing something. I do not want my children to get a smattering knowledge of French and of German, such a knowledge as was and now is given to boys of Latin and Greek; but I do want them to be taught to write and to speak those languages, as well as to read them—in a word, so to master them that they will thereafter be tools always ready to the hand. This requires labor. It is a thing which can not be picked up by the wayside, except in the countries where the languages are spoken. If academies in America are to instruct in this way, they must devote themselves to it. But the college requires all that they can well undertake to do. The college absolutely insists on Latin and Greek. . . .

But I now come to what in plain language I can not but call the educational cant of this subject. I am told that I ignore the severe intellectual training I got in learning the Greek grammar, and in subsequently applying its rules; that my memory then received an education which, turned since to other matters, has proved invaluable to me; that accumulated experience shows that this training can be got equally well in no other way; that, beyond all this, even my slight contact with the Greek masterpieces has left with me a subtile but unmistakable residuum, impalpable perhaps, but still there, and very precious; that, in a word, I am what is called an educated man, which, but for my early contact with Greek, I would not be.

It was Dr. Johnson, I believe, who once said, "Let us free our minds from cant," and all this, with not undue bluntness be it said, is unadulterated nonsense. The fact that it has been and will yet be a thousand times repeated can not make it anything else. In the first place, I very confidently submit, there is no more mental training in learning the Greek grammar by heart than in learning by heart any other equally difficult and, to a boy, unintelligible book. As a mere work of memorizing, Kant's "Critique of Pure Reason" would be at least as good. In the next place, unintelligent memorizing is at best a most questionable educational method. For one, I utterly disbelieve in it. It never did me anything but harm; and learning by heart the Greek grammar did me harm—a great deal of harm. While I was doing it, the observing and reflective powers lay dormant; indeed, they were systematically suppressed. Their exercise was resented as a sort of impertinence. We boys stood up and repeated long rules, and yet longer lists of exceptions to them, and it was drilled into us that we were not there to reason, but to rattle off something written on the blackboard of our minds. The faculties we had in common with the raven were thus cultivated at the expense of that apprehension and reason which, Shakespeare tells us, make man like the angels and God. I infer this memory-culture is yet in vogue, for only yesterday, as I sat at the commencement-table with one of the younger and more active of the professors of the college, he told me that he had no difficulty with his students in making them commit to memory; they were well trained in that. But when he called on them to observe and infer, then his troubles began. They had never been led in such a path. It was the old, old story—a lamentation and an ancient tale of wrong. There are very few of us who were educated a generation ago who can not now stand up and glibly recite long extracts from the Greek grammar; sorry am I to say it, but these extracts are with most of us all we have left pertaining to that language. But, as not many of us followed the stage as a calling, this power of rapidly learning a part has proved but of questionable value. It is true, the habit of correct

verbal memorizing will probably enable its fortunate possessor to get off many an apt quotation at the dinner-table, and far be it from me to detract from that much-longed-for accomplishment; but, after all, the college professes to fit its students for life rather than for its dinner-tables, and in life a happy knack at quotations is in the long run an indifferent substitute for the power of close observation, and correct inference from it. To be able to follow out a line of exact, sustained thought to a given result is invaluable. It is a weapon which all who would engage successfully in the struggle of modern life must sooner or later acquire, and they are apt to succeed just in the degree they acquire it. In my youth we were supposed to acquire it through the blundering application of rules of grammar in a language we did not understand. The training which ought to have been obtained in physics and mathematics was thus sought for long, and in vain, in Greek. That it was not found is small cause for wonder now. And so, looking back from this stand-point of thirty years later, and thinking of the game which has now been lost or won, I silently listen to that talk about "the severe intellectual training," in which a parrot-like memorizing did its best to degrade boys to the level of learned dogs.

But the case, as presented by Mr. Adams, was really much stronger than any individual experience could make it. He is descended from an illustrious line of scholars and statesmen — men eminent in affairs and of large national influence. His great-grandfather and his grandfather were Presidents of the United States, and his father represented this nation as minister to the English court at a very critical period in the relations of the two countries. These distinguished men were all graduates of Harvard College, and it must be assumed that they were capable of doing the best honor to their opportunities. But the representative of the fourth generation appeals to a family experience, extending through nearly a century and a half, in reprobation of the system which he had himself found so worthless and injurious. It was the same old story — Greek half-learned, good for nothing, and forgotten, while modern languages had to be acquired as indispensable implements of successful work in practical life. We can not give this interesting special history which so effectually clinches the case; but we quote the reference to the fourth and fifth generations, which shows that the system of fetichistic immolation is still practiced with desperate perversity at Harvard College:

I come now to the fourth generation, cutting deep into the second century. My father had four sons. We were all brought up on strict traditional principles, the special family experience being carefully ignored. We went to the Latin schools, and there wasted the best hours of our youth over the Greek grammar—hours during which we might have been talking French and German —and presently we went to Harvard. When we got there we dropped Greek, and with one voice we have all deplored the irreparable loss we sustained in being forced to devote to it that time and labor which, otherwise applied, would have produced results now invaluable. One brother, since a professor at Harvard, whose work here was not without results, wiser than the rest, went abroad after graduation, and devoted two years to there supplying, imperfectly and with great labor, the more glaring deficiencies of his college training. Since then the post-graduate knowledge thus acquired has been to him an indispensable tool of his trade. Sharing in the modern contempt for a superficial learning, he has not wasted his time over dead languages which he could not hope thoroughly to master. Another of the four, now a Fellow of the University, has certainly made no effort to keep up his Greek. When, however, his sons came forward, a fifth generation to fit for college, looking back over his own experience as he watched them at their studies, his eyes were opened. Then in language certainly not lacking in picturesque vigor, but rather profane than either classical or sacred, he expressed to me his mature judgment. While he looked with inexpressible self-contempt on that worthless smatter of the classics which gave him the title of an educated man, he declared that his inability to follow modern thought in other tongues, or to meet strangers on the neutral ground of speech, had been and was to him a source of life-long regret and the keenest mortification. *In obedience to the stern behest of his Alma Mater, he then proceeded to sacrifice his children to the fetich.*

LITERARY NOTICES.

LIFE OF SIR WILLIAM E. LOGAN, Kt., LL. D., F. R. S., F. G. S., etc., First Director of the Geological Survey of Canada. By BERNARD J. HARRINGTON, B. A., Ph. D. Montreal: Dawson Bros. Pp. 432.

PROFESSOR HARRINGTON has performed an acceptable service in giving us the story of Sir William Logan's life, so full of interest in connection with the development and conduct of the Geological Survey of Canada, of which Logan was the first director and zealous supporter, from the date of his appointment to this service in 1842, until his death in 1875.

Born of Scotch parents in Montreal, in 1798, and educated under a Scotch master, in 1814 he was sent with his brother Hart to the High School of Edinburgh, then in the zenith of its reputation. In 1816 Logan became a student in the university, but his university life closed with his first year, and he then went to London to take a place in the commercial house of his uncle, Mr. Hart Logan, where he remained for about ten years. The letters of Logan, to his brother chiefly, during this period are full of genial humor, and picture the writer like a mirror, showing up the sweetness and manly spirit of a most charming character. Those of us who knew Sir William only in later life, when he had espoused Science as his only mistress, gain a new view of the man as he unconsciously betrays his loving nature in these genuine letters.

His geological life began when in 1831, at the age of thirty-three, by a change in his occupation he was placed in charge of a copper-smelting and coal-mining enterprise in Wales, where his uncle had embarked in a smelting process on the waste slags of Swansea. His duties here led him to renew and extend his acquaintance with scientific pursuits. In 1840 he revisited Canada and renewed the associations of his early life. The first mention of his survey of Canada grew out of a conversation Logan had in 1841 with the late Dr. William B. Rogers, whom he met in Philadelphia. The subject had been brought forward by Dr. Rae, in 1832, by a petition to the Provincial Legislature, but repeated solicitations for money for this purpose failed to gain the attention of the Government until 1841, when £1,500 was secured for the purposes of a survey. The strong support of Mr. Logan by De la Beche, Murchison, Sedgwick, Buckland, and others, left no question but that Logan was the best person to place in charge of this important work. His appointment was confirmed in 1843, and he entered immediately with the utmost zeal and devotion upon the duties of his office. It is impossible to read his letters and journals at this time without a strong conviction of his rare talent and skill in meeting and overcoming difficultics which to a less bold and determined explorer would have appeared insurmountable. Professor Harrington's narrative sets forth clearly the successive steps of the work and its organization. Space forbids us to follow these interesting details. The whole volume sparkles with the good humor and bright remarks scattered in Logan's journal and letters, making it a volume of unusual interest both for the general and the scientific reader. In his Canadian work he was ably aided by Alexander Murray, for mnny years his principal geological assistant; Billings, his able paleontologist; Hunt, his chemist and co-worker in structural geology for about a quarter of a century; and later Hartley, a young geologist of uncommon promise, too soon removed by death, not to mention others of merit.

ON WORK AND WAGES. By Sir THOMAS BRASSEY, K. C. B., M. P. New York: G. P. Putnam's Sons. Pp. 284. Price, $1.

THE experience of that celebrated railroad-contractor, Thomas Brassey, Sr., with large numbers of workmen of various nationalities, and in various localities in Europe, forms the nucleus of this book. The greater part, however, consists of the results of inquiries into the labor question by the author, his son. Strikes and trades-unions are the first subjects discussed, and then follows a chapter, largely made up of illustrations and statistics, in which it is shown that the rate of wages is regulated, not by the fiats of trades-unions, but by demand and supply. The distinction between the rate of wages and the cost of labor is next pointed out, and abundantly illustrated. A comparison in respect to efficiency of the laborers of several European

countries is made, which places the English "navvies," in spite of their shorter hours and higher rate of wages, in a very favorable light. A chapter in regard to the "Influence of American Wages on the English Labor-Market" follows, in which the effect of the large emigration to this country is discussed. This chapter, evidently written before our resumption of specie payments, contains also an opinion in regard to "assisted emigrants," which is interesting as the expression of an English legislator several years prior to the present excitement. Co-operative establishments and boards of arbitration between employers and employed are two other important topics which are treated.

THE RELIGION OF HUMANITY. By WILLIAM FREY. "Index" Publication-Office, 3 Tremont Place, Boston. Pp. 85. Price, 15 cents.

THIS little work by an able Russian, who was formerly a professor of mathematics in the East, but has adopted this country for his home, was first contributed in a succession of papers to the pages of "The Index," and, having attracted a good deal of attention, they have been reissued in this separate and more accessible form. Professor Frey takes up the fundamental questions in relation to the nature, basis, applications, and uses of religion, and, while criticising the view adopted by Herbert Spencer upon the subject, is more inclined to accept that of Auguste Comte. While repelled from Spencer's view, which confines religion to man's mysterious relation to the unknowable Power manifested in the universe, but which is beyond the reach of human intelligence, Professor Frey is attracted to the doctrine of Comte, which makes man, or humanity, the object of religious feeling, veneration, and worship. Being deeply concerned with the interests of humanity, and aspiring after a better state of things than now exists, and recognizing the great power of the religious sentiment, he sees in "The Religion of Humanity" the greatest means of future progress, and the only hope of any substantial improvement in the social condition of mankind. We are not prepared here to consider the grave issues involved in this discussion, but may cordially commend the pamphlet before us as an earnest contribution to the inquiry which, if not conclusive, will be found suggestive, and probably helpful to many who are seeking light upon a much confused and deeply perplexing subject.

THE CAUSE OF VARIATION. By M. M. CURTIS. Marshall, Minn.: Published by the author. Pp. 115.

THE author's answer to this problem is—labor. He instances the comparative fewness of the larger carnivora, which obtain their food easily, and the large numbers of wolves and other animals, which obtain subsistence only by ceaseless activity, as showing the effect of labor on the development of animals. He maintains, further, that suspension of effort causes proportional loss of consciousness. Intelligent acts are performed without consciousness, hence there is an unconscious intelligence inherent in every structure, giving evidence of form or design; moreover, this intelligence is capable of transmigration. Communities follow the same rule as individuals. "When labor is partially suspended among the individuals in such a community, or, owing to the invention of labor-saving machines and division of labor, becomes more simple, the community begins to manifest the characteristics of decay and dissolution." It would seem to be the author's belief that those who make a failure of this life are, after a term of purgation, to have another try at it, for he ends by saying: "From the fire we came, and to the fire we are going, unless we comply with the conditions of life and consciousness. The answer to the riddle fate would have us read is this: 'Unless ye labor ye shall perish.' If we can not comply with that, we shall probably continue to be warmed over until we can."

NOTES ON EVOLUTION AND CHRISTIANITY. By J. F. YORKE. New York: Henry Holt & Co. Pp. 294. Price, $1.50.

THE author puts forth this book as an aid to answering the question, "Is there in the teaching of Christ an originality so wonderful as to be accounted for only by the assumption of a special divine revelation?" The first chapter is devoted to a sketch of some Eastern religions which preceded Christianity. The second is mainly made up of quotations from Christ's teachings,

and of similar passages in other writings, while the remaining chapter takes up the difference between natural morality and the religious systems of ethics. The author's estimate of Christianity is as follows: "The Eastern world was fortunate in possessing many great moral and religious teachers; and it was out of their doctrines, ever increasing in perfection as time went on, that was gradually and naturally built up the most complete and beautiful religion of all. Hence (we may say) it was *necessary* that, in the process of evolution, this development should be reached, and that Christianity should come: yet this is no reason why we need hesitate to add—but blessed be he through whom it came." Moreover, he considers that the evidence brought forward tends to show "that much of Christ's doctrine was necessarily of only temporary and local value; but that the Church has greatly hindered the progress of knowledge and scientific morality by insisting that her founder's teaching is final on all points," and "that science is now proving the origin and nature of man to be entirely different to those assumed by religious teachers, and thereby contradicting much that is essential to their doctrines."

EVE'S DAUGHTERS; OR, COMMON SENSE FOR MAID, WIFE, AND MOTHER. By MARION HARLAND. New York: John R. Anderson and Henry S. Allen. Pp. 454. $2.

A BOOK of sound principles on the instruction and training of girls and women with reference to the principal function of their life. That it has met a large demand and approval by the public is attested by the fact that it is now in its twentieth thousand. The subject of the book is the training and treatment of woman, in respect chiefly to her physical well-being and moral culture, in every age and condition of life—as an infant, as a girl at play, as a school-girl, "young lady," wife, and mother. The infant is commended to the mother's personal nursing and care, and to an enlightened *régime*, in order to give which the mother must seek the necessary knowledge. For the girl are claimed the freedom of action that will secure to her the best development, and the instruction and the sincerity of instruction that will best help her to make herself a true and sound woman. As the school-life period approaches, and the critical period of the woman's life with it, more attention is required to secure a proper development of the physical and mental functions than even in infancy, and the subject receives a correspondingly greater particularity of treatment. The calling of the woman to be a housekeeper and the trainer of a new family and the bearing of her education to those ends are given their proper prominence. We have also chapters on what women who have grown up to be young ladies should do for their mothers, on dress, on the cure of gossip, on the period of marriage and the duties of the expectant mother. The book is a woman's book on a woman's subject, in which the plainest truths are presented in the most forcible manner, yet with the most fully refined delicacy; and it is a book that will help women, and in helping them will help the human race.

LEGAL PROVISIONS RESPECTING THE EXAMINATION AND LICENSING OF TEACHERS. Washington: Government Printing-Office. Pp. 46.

THIS pamphlet, published by the Bureau of Education as one of its "Circulars of Information," gives summaries of the rules prevailing in the several States for ascertaining the qualifications of teachers preparatory to giving them licenses. While the Commissioner of Education has no desire to call undue attention to examinations, and deprecates the cramming and the danger of making them an end in education which it is likely to induce, he hopes to secure a good purpose by showing how it has seemed best to the people of the different States to determine whether the teacher has the qualifications required; for which no better general way seems to have been found than some system of examination.

BACTERIA AND THE GERM THEORY OF DISEASE. By Dr. H. GRADLE, Professor of Physiology, Chicago Medical College. Chicago: W. T. Keener. Pp. 216. Price, $2.

SINCE this book consists of medical lectures, the treatment of the subject is naturally technical rather than popular. It is a presentation of the results so far attained in researches as to the nature of germs, and their action as agents of disease.

SCHOOL-BOOKS ON PHYSIOLOGY AND HYGIENE. By STANFORD E. CHAILLÉ, of the University of Louisiana.

HAVING received many requests for advice respecting the best school text-books on hygiene, Dr. Chaillé examined the various books in the market, for comparison with one another and with his own standard of merit, which was that they should give predominance to teaching the care and proper use of the organs and the preservation of health. Of twenty books regarded as living candidates for favor, three were found fairly suitable for children ten or twelve years of age, while the others were more or less adapted to the comprehension of youth of different greater ages. Of the more advanced works, Draper's, Dalton's, and Huxley and Youmans's "are excellent," and the two latter and Foster's primer (primary) "bear the unmistakable stamp of the master's hand," and illustrate the rule "that even the most elementary books can be better written by distinguished experts." The pervading fault of most of the books is that they pay too little attention to hygiene.

THE EVOLUTION OF THE AMERICAN TROTTING-HORSE, pp. 5; and THE AMERICAN TROTTING-HORSE: WHY HE IS AND WHAT HE IS, pp. 28. By Professor WILLIAM H. BREWER, of Yale College.

PROFESSOR BREWER regards the trotting-horse as essentially a development of the present century, and as still in process of evolution. His training has been stimulated by a combination of influences. The ancients did not have "trotters," and did not want them, because, not possessing light spring-wagons, they knew nothing of driving for pleasure, and for riding they preferred animals of more even gait. A little attention seems to have begun to be paid to trotting at about the time of the close of the Revolutionary War; the first mention of a "trotting-stallion" is found in 1788. The first definite notice of trotting on the course is in 1806, when Yankee trotted a mile in two minutes and fifty-nine seconds. At about this time a prejudice, resulting in the enactment of prohibitory laws, was developed against horse-racing (competitive running), and trotting-matches against time were introduced. A demand for trotters sprang up in the French West Indies; and light spring-wagons were invented, and, as they became fashionable, the taste for fast driving increased. These and kindred circumstances favored the development of the trotting-horse, and it has gone on speedily. In 1806, 2·59 was the fastest time that had been made by trotting; 2·40 became the synonym for speed in 1824. In 1843, one horse, Lady Suffolk, had trotted a mile in less than 2·30; in 1882, 1,654 horses had made that record, and the fastest time had been reduced by Maud S. to 2·10¼.

NATURAL CURE OF CONSUMPTION, CONSTIPATION, BRIGHT'S DISEASE, NEURALGIA, RHEUMATISM, COLDS (FEVERS), ETC. The Origin, Prevention, and Removal of Disease. By C. E. PAGE, M.D. New York: Fowler & Wells. Pp. 278. Price, $1.

THE author maintains that bad living is the primary cause of the diseases named; that no mere accident of exposure, like those to which they are commonly ascribed, is competent to produce them unless the system has already been made peculiarly sensitive to them by habitual overloading of the stomach, living in bad air, or indolence; and that they are susceptible of being cured by adopting and adhering to a "natural" treatment and *régime*. In all this Dr. Page agrees fully with Dr. Oswald, and quotes him freely. He gives several remarkable examples of wonderful cures which he knows of having been effected by following the principles he lays down. Whether the course he recommends will be quite as effective, in all cases, as he seems to believe it will be, or not, he has laid down principles which may be followed with profit, and the following of which may relieve many cases regarded as desperate; and he has given the public a most valuable manual of hygiene.

"THE MEDICO-LEGAL JOURNAL." Vol. I, No. 1, June, 1883. Published under the Auspices of the Medico-Legal Society of New York. Pp. 118. Price, $3 a year.

THIS is claimed to be the only journal in any part of the world devoted exclusively to the science of medical jurisprudence. It will publish the leading papers of the Medico-Legal Society, and a summary of its transactions and contributions from all

sources on subjects and questions appropriate to its sphere. The present number contains a portrait of Dr. George W. Beard, who was a leader in projecting the journal; the inaugural address of President Clark Bell, of the Medico-Legal Society, in which is embodied a review of the progress of medical jurisprudence in the several countries of the world; reports on coroners, medical examiners, amendments to the lunacy laws of New York, and on the Pennsylvania lunacy laws, and miscellaneous matters.

VAN LOAN'S CATSKILL MOUNTAN GUIDE FOR 1883. With Bird's-eye Views of the Mountains, and Maps. Catskill, N. Y.: Walton Van Loan. Pp. 126. Price, 40 cents.

BESIDES notices of the principal resorts and attractions in the mountains, with directions for reaching them, and directories of hotels and boarding-houses, arranged by towns, the "Guide" contains some well-considered and condensed notes, intended to assist in geological observations in the Catskill region. The whole would be a valuable and desirable acquisition to tourists, but for the sprawling advertisements that are intruded among the reading-matter. In a book to which a price is attached, the two kinds of matter should occupy their separate pages.

POLITICAL ECONOMY. By FRANCIS A. WALKER. New York: Henry Holt & Co. Pp. 490. $2.25.

THIS volume is the fifth of the "American Science Series," the principal objects of which are defined to be "to supply the lack of authoritative books whose principles are, so far as practicable, illustrated by familiar American facts, and also to supply the other lack that the advance of science perennially creates, of text-books which at least do not contradict the latest generalizations." The list of the works to be included in the series shows that the publishers have made it a rule to go to authors whose names carry authority, and who speak as original investigators, having their facts at first hand. Professor Walker's discussion, in this volume, of the questions included under the general title of political economy in their varied and complicated aspects and relations is full and rich in citations of authorities and in illustrations, and covers such a multiplicity of topics that it would be impossible, in an ordinary notice, to give even an outline of it. It is conducted with such clearness as to make the book quite readable and readily understood. After the introductory chapter, or part, in which the "Character and Logical Method of Political Economy" are considered and its claims to be ranked as a science and its relations with other branches are discussed, the whole subject is topically divided and treated under the several heads of "Production," "Exchange," "Distribution," "Consumption," and "Some Applications of Economical Principles." The numerous questions growing out of the labor agitation, the subjects of the currency, paper money, bi-metallism, protection *vs.* free trade, and other economic topics now vital among us, receive attention in their appropriate places.

"MASTERY." Useful Pastimes for Young People. A Weekly Magazine. New York: Mastery, 842 Broadway. Pp. 16. Price, 7 cents a number, $3 a year.

THE character of this publication is well indicated by the subordinate title. It is intended not only to amuse and instruct, but also to direct the natural bent of its readers to some practical work; and the numbers we have seen of it seem well adapted to these purposes. In two of them we have a story illustrating the magical effects that may be wrought through simple applications of modern scientific discoveries; papers relating to natural history, astronomy, and physiology; and lessons and suggestions regarding various arts and sports with which youth may find it pleasant—and perhaps profitable—to amuse themselves.

A VISIT TO CEYLON. By ERNST HAECKEL. Translated by CLARA BELL. Boston: S. E. Cassino & Co. Pp. 337. Price, $2.

A BOOK from an author who has had such an influence upon the scientific thought of his countrymen as Herr Haeckel has exerted must have a value of its own, even though it be not directly scientific. The "Visit to Ceylon" records the impressions of a tourist; yet not of the ordinary tourist, who skims over a country and takes the merest superficial view of everything, but

of a traveler whose mission is scientific, and who expects to make a study of all that he sees, and to draw a lesson valuable to students and to mankind from every object he meets. The impressions are recorded here. The studies will come afterward, and the fruits of them, probably, be given to the world in volumes which will be heavier in proportion as they are of more solid value. Professor Haeckel, as may be inferred from the character of his mind, saw more than common tourists do, and, in one direction at least, more intelligently. To him, in Ceylon—a country of tropical luxuriance, contrasting strongly with cold and frugal Germany—everything was fresh, new, and full of blooming life. These qualities are exhibited also by his narrative, which is brilliant in color, warm with admiration, and diversified with the lively effusions of an imagination which might have made a poet had it not been bestowed upon a student of prosaic biology.

THE MAINTENANCE OF HEALTH. A Medical Work for Lay Readers. By J. MILNER FOTHERGILL, M. D., M. R. C. P. New York: G. P. Putnam's Sons. Pp. 366. Paper. Price, 60 cents.

A WORK that was first published several years ago, but which is so thorough in its treatment of the subject, and contains so much that is of practical value, that it still remains one of the best books of the kind in the market. We have already given full notice and commendation of the two previous editions, the larger and expensive one, and the more popular edition in 12mo; so we need only mention the appearance of this cheap edition, and say that the publishers deserve the thanks of the public for issuing it.

PUBLICATIONS RECEIVED.

United States Hay Fever Association. 1883. Portland, Me.: Hoyt, Fogg & Donham. Pp. 30.

The People's Power; or, How to wield the Ballot. By Simeon Stetson. San Francisco: Hinton & Co. 1883. Pp. 63.

Johns Hopkins University Studies in Historical and Political Science. Herbert B. Adams, Editor. III. "Local Government in Illinois," by Albert Shaw, A. B.; and "Local Government in Pennsylvania," by E. R. L. Gould, A. B., pp. 37. IV. Saxon Tithing Men in America. By Herbert B. Adams, Ph. D. Pp. 23. V. Local Government in Michigan and the Northwest. By Edward W. Bemis, A. B. Pp. 25. Baltimore: Published by the University. 1883.

The Factors of Civilization. Vol. I. Atlanta: J. P. Harrison & Co. 1883. Pp. 347.

Bulletin of the American Museum of Natural History, Central Park, New York. Vol. I, No. 4. The Atlantic Right Whales. By Joseph Bassett Holder. W. C. Martin, printer. 1883. Pp. 83, with Plates.

The Modern Polytechnic School. Inaugural Address by President Charles O. Thompson. Terre Haute, Ind. 1883. Pp. 27.

The Stuart Period. From a Medical Standpoint. By R. L. Macdonnell, B. A., M. D. 1883. Pp. 23.

The Geology of Philadelphia. By Professor H. Carvill Lewis. 1883. Pp. 21.

Lake Agassiz. A Chapter in Glacial Geology. By Warren Upham. Jones & Kroeger, Printers. 1883. Pp. 25.

Statistical Tables from the History and Statistics of American Water-Works. By J. J. R. Cowes. "New York Engineering News." 1883. Pp. 120.

Seventh Annual Report of the State Board of Health of Wisconsin. 1882. Madison Democrat Printing Co. 1883. Pp. 265.

On a New Genus and Species of Blastoids. By Charles Wachmuth; and Descriptions of some New Blastoids from the Hamilton Group. By W. H. Barris. Springfield, Ill.: H. W. Rokker, printer. 1883. Pp. 21. Illustrated.

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Human Proportion in Art and Anthropometry. By Robert Fletcher. Cambridge, Mass.: Moses King. 1883. Pp. 37, with Plates.

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POPULAR MISCELLANY.

A Cod-Mountain in the Sea.—The "conference" at the Fisheries Exhibition was opened with a lecture by Professor Huxley, in which he said: "Those who have watched the cod-fisheries off the Loffoden Isles, on the coast of Norway, say that the coming in of the cod, in January and February, is one of the most wonderful sights in the world; that the cod form what is called a 'cod-mountain,' which may occupy a vertical height of from twenty to thirty fathoms—that is to say, one hundred and twenty to one hundred and thirty feet in the sea; and that these shoals of enormous extent keep on coming in great numbers from the westward and southward for a period of something like two months. The number of these fish is so prodigious that Pofessor Sars tells us that when the fishermen let down their loaded nets they feel the weight knocking against the bodies of the codfish for a long time before it gets to the bottom. I have made a computation which leads to this result, that if you allow each fish four feet in length, and let them be a yard apart, there will be in a square mile of such shoals something like one hundred and twenty million fish. I believe I am greatly understating the actual number, for I believe the fish lie much closer. These facts about the cod apply also to the herring, for not only Professor Sars, but all observers, who are familiar with the life of the cod when it has attained a considerable size, tell us that the main food of the cod is the herring, so these one hundred and twenty million of cod in the square mile have to be fed with herring, and it is easy to see, if you allow them only one herring a day, that the number of herring which they will want in a week will be something like eight hundred and forty million."

Copyright in China.—A pamphlet on this subject, by Dr. D. J. Macgowan, has been published in Shanghai, and from the copy sent us by the author we extract the following: "One finds not infrequently on the title-pages of Chinese newly-published books a caution against their unauthorized publication, in some instances threatening the forfeiture or destruction of all blocks that may be cut for their printing, showing at once that literary property is liable to be stolen, and that redress is afforded to authors thus wronged. The penal code, however, will be searched in vain for an enactment on the subject of copyright. Chinese law has never conceived it necessary to specify that particular form of robbery which consists in despoiling a scholar of the fruit of his toil, any more than to name the products of husbandmen and artisans as under the protection of law, all alike being regarded as property by natural right. The offending publisher is arraigned and punished under that section of the code which takes cognizance of larcenies of a grave character, the penalty, to which one who prints and sells an author's works without authority is liable, being one hundred blows and three years' deportation. This right of exclusive publication by an author of his works is held in perpetuity by his heirs and assigns. It is not the custom with Chinese authors to make arrangements with publishers, that being undignified. They have their books cut and printed on their own premises, and then sell them to the trade, usually at twice the cost of publication. Manuscript novels and other ephemeral books are sold to publishers, but in such a case neither author nor publisher can prosecute a printer for bringing out a rival edition. Among the subjects which this new era brings to the consideration of Chinese statesmen, that of international copyright may be included. Cheng Ch'engchai, an artist and also a poet, has lately published several hundred of his choice pictures, accompanied by stanzas, the fruit of a life of toil. There is some prospect of his literary harvest being blighted by the appearance of his work at four dollars a set—the author's charge being eight dollars. The pirated copies come from Japan. In Japan the rights of authors are regarded in the same light as in China, but, as a license must first be obtained before a book can be published, the prevention of copyright infringements is more facile there than in China. It is well known that the Japanese Government have long been maturing a copyright law, and the time is favorable, therefore, for these two empires to concert measures for increasing the security of literary property.

Spontaneous Combustion.—Many fires, which appear to be of mysterious origin, can with great plausibility be referred to spontaneous combustion. Such was probably the cause of a fire which destroyed the carriage-shops at Forest Hill, Maryland, a year or two ago. This is indicated by the fact that, shortly after the shops were rebuilt, a hole was burned through one of the floors and the establishment narrowly escaped destruction a second time from the spontaneous combustion of a rag saturated with Valentine's patent wood-filling, which had been left in the paint-room overnight. Rags similarly saturated had been carelessly left in the old building just before the fire. To test the liability of this substance to take fire, a cloth was saturated with it and put in a tin bucket. Combustion began within a few hours afterward. Lamp-black is extremely liable to take fire spontaneously, particularly if a small quantity of oil is in contact with it. It can not be safely wrapped up in printed paper on account of the danger from the oil in the ink. A tub of loose lamp-black in a carriage-shop in England was set on fire in consequence of the presence of a palette-knife on which a little oil had been left. Even the dry paint which accumulates on the blades of these knives near the handle is sufficient to cause ignition. It is, however, only the small quantities of oil that are dangerous; the peril is greatly reduced if the lampblack is saturated with oil. The danger of the spontaneous combustion of coal in cargoes is generally recognized by shippers and insurance-men.

Chiriqui Funerals.—M. Alphonse Pinart has recently given an account, before the Ethnographical Society of Paris, of the burial-places and funeral customs of the Dorasks, a people of the Isthmus of Darien, whom he regards as of Mexican origin. The burial-places, called *huacas*, which he claims to have discovered and excavated, are most abundant in the valley of Chiriqui, though they may be found in some other places. They generally lie at the foot of little hills, and are always marked by the presence of stones covered with figures and inscriptions. They are shaped like a well, the entrance to which is marked by a cross of stones, some twenty feet, more or less, in diameter, and are from six to thirty feet deep. At the bottom are excavated niches, corresponding with the four points of the compass, in which are deposited the bones and the articles that are buried with them —garments, vessels of most perfect shape and finish, and ornaments of gold, either solid or mixed with copper, representing animals, and undoubtedly of artistic value. The bones in these tombs are always broken, in accordance with a custom which prescribes the breaking of them as one of the peculiar features of the funeral rites. On the death of one of the Indians, the body is wrapped in a cotton shroud, and, after a short ceremony with a funeral oration, is borne to a solitary place in the forest, where it is laid upon a kind of scaffold covered with branches of trees, and left for a year. At the expiration of this period, the *kanuru*, a functionary expressly designated for this duty, and who is the only one that can perform it without having to undergo a costly purification, goes to the spot and prepares the corpse for the final ceremonies. Removing the limbs, he collects the bones, cleanses them from all adhering flesh, and breaks them up, together with the skull, and compresses the fragments into a small packet no larger than a new-born child. Having performed this duty, he calls his assistants, who have been waiting in the vicinity, and they bear the packet to a kind of catafalque, around which funeral services are held through parts of three days. At sunset of the third day the *kanuru* goes alone with the body, the dresses, and the ornaments that have been provided for the sepulchre, to the family tomb. No white man has ever been permitted to witness this part of the ceremonies.

Capacity of Brazilian Indians.—An anthropological collection, illustrative of the life of the savage tribes of South America, particularly of Brazil, is now on exhibition in London. Besides the scientific and artistic value of the cabinet, the collector, Senhor C. Ribeiro, seeks to commend the value of the country for colonization, and to remove prejudices against it. Among other things, he wishes to show that the Botocudos Indians are not the dangerous savages they have been reported, and that

the specimens of their handiwork—useful articles of straw and bark, tastefully made head-dresses of feathers, and ingeniously fashioned weapons of war and the chase, decorated in geometrical figures—point to a capacity for civilization. Hitherto these Indians have had the advantages of civilization presented to them too often only with arguments of fire and sword; but Senhor Ribeiro asserts that they may be easily induced to work, and that with kind treatment and proper direction they might be made instrumental in the development of the natural wealth of their land.

John Duncan, the Weaver-Botanist.—John Duncan, the Scotch weaver and botanist, to whose scientific merit attention was drawn about two years ago, just in time for public recognition to make his dying days more comfortable, gained a thorough knowledge of botany and formed a valuable herbarium in the face of formidable difficulties arising from poverty and laborious occupation. He had also some knowledge of astronomy, learned something of Latin, so that he might understand botanical terms, and even tried Greek. In his pursuit of knowledge he bore privation cheerfully, denying himself almost the necessaries of life to buy books, and carrying on his studies in a loft above a stable, lighted only by an unglazed hole in the door, where he lived without fire or candle for fear of burning the thatch. His love for plants began to develop when he was about ten years old, and out on farm-service. "I just took a notion," he used to say, "to ken ae plant by anither when I was rinning aboot the braes. I never saw a plant but I lookit for the marrows o't" (the like of it); "and as I had aye a guid memory when I kent a flower ance, I kent it aye." He read in the "Herbal of Nicholas Culpepper," imbibed that quaint author's doctrine of the effect of astrological influences on plants, and was led from it to study astronomy as far as he could go without mathematics. When forty years old he fell in with a gentleman's gardener of the village who was also a scientific botanist, and was introduced by him to the regular study of the science. Before long he had learned enough to help his friend in the formation of a herbarium. For many years, at the season when weaving was dull, he was accustomed to go about doing harvest-work and studying the flora of Scotland, while he earned a little extra money; and he turned these excursions to such good account that, when in his old age he handed over his collection to a friend to be catalogued, as a preliminary to presenting it to Aberdeen University, it contained 1,131 specimens of the 1,428 species that form the flora of England and Scotland. A selection was made from this collection, and 750 specimens were finally presented to the university. Up to his seventy-third year, Duncan was able to earn his own living by work at the loom. Then work became scarce and his strength feeble, and he was forced to seek parochial relief. Finally attention was called to his case in "Nature," in January, 1881, and a subscription was made for him. The story of his life has been told by Mr. W. Jolly, in a book which has just been published in London.

A Smoke-consuming Furnace.—Mr. P. H. Jackson, of San Francisco, has patented a device for securing the more perfect combustion of coal by, first, securing the removal of the carbonic acid which arises from the fire, and, if allowed to remain mingled with the other products, interferes with their further combustion; and, second, by causing the hydrocarbons and other combustible products to be drawn under the furnace and perfectly mixed with atmospheric air before passing through the fire again. The carbonic acid is eliminated through the action of the affinity of carbonate of soda, which is placed in a chamber above the furnace, whence an outlet is provided for the escape of any surplus of acid. The hydrocarbons are drawn down under the furnace through a pipe at the side of the stove, by the suction of a strong current of atmospheric air, which is made to flow to feed the fire through a chamber into which the lower end of the pipe abuts.

Curves of Mortality in London and New York.—Dr. John W. Tripe, President of the Society of Medical Officers of Health, England, has observed, from a comparison of the mortality returns of London and New York, that the curve representing the prev-

alence of scarlet fever is for New York entirely opposed to that for London. Thus, the lowest death-rate from this disease happens in New York between the end of July and early in October, when the mortality from it in London is greatest. Again, the curve of lowest mortality in London falls in February, March, and April, reaching its lowest point when the mortality is greatest in New York. "We are therefore," Dr. Tripe remarks, "driven to the conclusion either that the same meteorological changes which appear to increase the disease in London decrease it in New York, or, that the mortality per cent of attack is greater at one period of the year than at another. Similar opposing curves are noticeable as regards whooping-cough. These are by no means satisfactory results to have arrived at after so much labor. On the other hand, the curves of mortality from small-pox, measles, diphtheria, typhoid fever, diarrhœa, phthisis, bronchitis, pneumonia, heart-disease, and apoplexy closely correspond in both these great cities."

Suggestions about Bathing.—When and under what conditions a bath will be most beneficial is an important question. The important point is to secure a speedy and healthful reaction, or return of the blood to the surface, and all the conditions should be arranged with reference to that end. Obviously, says the "Lancet," it is not right to dare the dangers of a chill either when undressing or by immersion in the cold water. In most cases a sweating surface indicates some measure of exhaustion already set in; and it is unwise to bathe when copious perspiration has continued for an hour or more, unless the heat of the weather be excessive or the sweating has been induced by loading with clothes rather than by exertion. When much perspiration has been produced by muscular exercise, it is unsafe to bathe, because the body is so fatigued and exhausted that the reaction can not be insured, and the effect may be to congest the internal organs, and notably the nerve-centers. The last gives cramp. If the weather be chilly, or there be a cold wind, so that the body may be rapidly cooled at the surface while undressing, it is not safe to bathe. Under such conditions, the further chill of immersion in cold water will take place at the precise moment at which the reaction consequent upon the chill of exposure by undressing ought to take place, and this second chill will not only delay or altogether prevent the reaction, but will convert the bath from a mere stimulant to a depressant, ending in the abstraction of a large amount of animal heat and congestion of the internal organs and nerve-centers. The aim must be to avoid two chills, and to make sure that the body is in such a condition as to secure a quick reaction on emerging from the water, without relying too much on the possible effect of friction by rubbing. The actual temperature of the water does not affect the question so much as its relative temperature in comparison with that of the surrounding air. It ought to be much lower than that of the air. These maxims receive a striking re-enforcement from the case of a young soldier who a few days ago plunged into the river near Manchester, England, after having heated himself by rowing. He was immediately taken with cramps, and was drowned. When taken out, his body was found "twisted," and the vessels of his head showed every evidence of congestion. Quintus Curtius relates that Alexander the Great attempted a bath in the Cydnus on a very hot day, when all sweating. "Hardly had he entered, when his limbs became suddenly stiff, the body pale, and vital heat seemed by degrees to abandon him. His officers received him almost expiring in their arms, and carried him almost senseless to his tent.

Satisfying Religious Scruples.—Dr. Francis Day, formerly inspector-general, stated, in a recent lecture on the fisheries of India, that while as Buddhists the Burmans profess a religious horror of taking the lives of the lower animals, they are immoderate ly fond of fish-diet, and pretend to console their consciences, while indulging in it, that the death of the fish must be laid to the fishermen, and can not be charged against them! The prospects of the fishermen in the next life appear, however, to be most dreadful, for the temples have pictures of terrible and artfully contrived tortures to which they will be condemned. The *poon-*

gees, or priests, are supposed to be, as is their duty, particularly diligent in teaching the wickedness of eating fish, but they like to eat them; this is illustrated by the story of a fisherman on the Irrawaddy, who built a monastery in the hope of earning the highly-prized title of founder of a religious home. Many poongees came to visit him, but none of them staid long, until at last one came who seemed to find the quarters and the fare to his liking. The fisherman one day asked this holy man anxiously the question, "Why, my father, do not the poongees approve my monastery, for none but yourself have remained over the going down of two suns?" The poongee told him it was because he broke the law by depriving fish of life. "True," answered the fisherman, "but, were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law than to feast while breaking it!" The disciple took the priest at his word, and refrained from fishing for three days, giving his guest in the mean time only vegetables for his meals. On the fourth morning, when the same fare appeared, the poongee said, "My son, when you fish the river, does your net extend all across, permitting no fish to escape, or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one third of the way," he answered. "Well, then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into the net, the fault is theirs, and not yours. Even Gautama blessed the hunter who met him when he was hungry, and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring whence it had been procured.

Some Newly Remarked Instincts.—Mr. Charles S. Clarke, of Peoria, Illinois, recently related, in a lecture before the Scientific Association of that city, an incident, the key to which, if it is found to be of general application, may disclose a hitherto unnoticed principle of our organization. A child had been lost in the hazel-bushes near its home, and, after all the neighbors had failed to find it in the course of a day's search, an old trapper was called in to assist. He marked out with flags a rough circle of about two miles in diameter, starting from the bushes and bearing to the left toward the house; then set the company he had collected in a line along the radius of the circle, and moved them so as to examine the ground all over. The child was soon found. When asked the reason of his proceeding, he replied: "It was very simple. Probably you know that lost people always go round in a circle, but may be you don't know that they always circle agin the sun (from right to left)." "No," replied the speaker, "I have never heard that." "Well, they do," the hunter said, "and every Indian and trapper from here to the mouth of the Columbia will tell you so. Lost men or women will always make the circle within three miles in diameter, and children in two, unless they are led away by a trail or stopped by a stream." In the course of the same address, Mr. Clark also gave the following example, illustrating how much the senses can be cultivated: "While we were talking, two young dogs had gone to a small eminence, a few rods from the old man's cabin, and, with their noses in the air, would at short intervals utter a low, warning cry. The trapper soon noticed it, and, calling to an old dog in the cabin, he said, 'Dave, go up yonder and see what those youngsters are making a fuss about.' The dog, after reaching the place and standing a moment with outstretched neck and distended nostrils, gave a clear but low warning notice, such as I had never heard from a dog before. 'Is that so, Dave?' said the old man. He immediately went to the same place and began to sniff the air, much after the manner of the dogs. 'Sure enough, Dave,' he said, 'you are right.' 'What is it?' I asked. 'The prairie is on fire,' he said, 'some thirty or forty miles northwest from here! I must set a back-fire on the other side of the creek, or my cabin and bees will be in ashes before morning, should

the wind raise; and, by-the-way,' he said, 'you go back by the way you came, and tell the people to set back-fires at once, and have them send word to the settlements below.' Before starting I tried my sense of smell, and, although I imitated the attitude of the trapper and the dog, I could detect nothing but the sweet October air." The warning given by the dogs was justified in the event.

NOTES.

MR. HERBERT SPENCER is taking a long vacation in Scotland, occupied with his favorite recreation of salmon-fishing. A paragraph in "Mind" announces that he has declined the honor of election to the French Academy, on grounds of principle.

HERREN FISCHER AND RUDOLPH have produced by the action of chloride of lime on acetaniline at a temperature of 270° C. a new coloring-matter of a brilliant yellow, which they call *flavaniline*. It has an especially brilliant appearance, with a remarkable green fluorescence on silk fibers.

PROFESSOR STEPHEN ALEXANDER, Professor Emeritus of Astronomy at Princeton, New Jersey, died June 26th. He had been connected with the college at Princeton since 1840, first as Professor of Astronomy, and afterward of Astronomy and Mathematics.

A DISCOVERY is announced by the "Union Médicale" which promises to throw considerable light on the subject of prehistoric man. While running a gallery in a coal-mine at Bully-Grenay, a subterranean cave was broken into, in one chamber of which were found six fossil human bodies—a man, two women, and three children—together with implements, and fragments of lower animals. Another chamber contained eleven human bodies, precious stones, and numerous other articles, while on the walls were drawings of combats between men and huge beasts.

ACCORDING to legends of colonial times, seals were formerly common in Long Island Sound, Red Rock in the estuary of the Quinepiac River being their favorite resort. A few are still seen or caught every year. Mr. H. C. Hovey states, in the "Scientific American," that more than the usual number have been seen during the recent cold season. Two fine specimens were caught on the 11th of April, near Guilford, Connecticut.

PROFESSOR O. C. MARSH, of Yale College, has been chosen a member of the Munich Academy of Sciences, Bavaria.

DR. BOWDITCH, of the National Board of Health, objects to dependence on sewerage for the sanitation of sea-side resorts, that the sewers will leave the refuse matter where it is liable to be brought back to the shore by returning tides. He commends the method adopted at an hotel at Cape May Point, of systematic deportation of sewage material. The cess-pools are emptied every morning by means of odorless excavators, and their contents are conveyed to the hotel company's farm, where they are deposited in trenches with sea-weed and covered with earth, to be converted by the next spring into excellent manures.

MR. RUSSELL, a skillful observer at Carson City, Nevada, is convinced that the impressions in the sandstone there which have been talked of as human footprints, are really the tracks of an edentate, the moropherium. The mud where the tracks occur was so soft that the animal's foot sunk into it, pushed a ridge upward two or three inches higher than the outside level, and came out with a mass adhering to it. Consequently no marks of claws or skin-creases are to be looked for.

M. GAY-LUSSAC, son of the celebrated chemist, and himself an able chemist and metallurgist, has recently died, at the age of sixty-three.

IN testimony to the value of M. Pasteur's researches, the French Government has increased his pension from twelve thousand francs to twenty-five thousand francs yearly, and has made it payable to his wife if she should outlive him.

BARON NORDENSKIÖLD was to start from Sweden, May 20th, on an expedition at the expense of his old friend Oscar Dickson, for the exploration of Greenland. He believed that the interior of that country, which is generally thought to be a vast plain of ice, is partially free from ice during the summer, basing his opinion on the warmth of the winds from the interior, and will endeavor to reach it. He will also seek for traces of the old Norse colonies, which have been lost since the fourteenth century.

DR. MICHAEL FOSTER has received the appointment to the new chair of Physiology at Cambridge, and Dr. A. Macalister to that of Anatomy.

THE Academy of Natural Sciences of Philadelphia has recently come into possession of the William S. Vaux mineralogical and archæological collection. The mineralogical department includes more than six thousand trays of specimens, many of them of rare beauty and perfection, and is valued at $40,000; while the archæological collection is estimated to be worth at least $10,000.